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[OFFICIAL NOTICE.]

Ohio Gas Light Association.

OFFICE OF SECRETARY,
COLUMBUS, O., February 21, 1889.

To Members of the Ohio Gas Light Association:—As heretofore announced the Fifth Annual Meeting of this Association will be held at Mansfield, Ohio, March 20 and 21, 1889; the first day's session to begin at 9:30 A.M. standard time.

The following papers are promised for the meeting:

1. "The Methods of Taxation of the Different Gas Companies, and a Comparison of the Same," by H. Wilkiemeyer, Portsmouth, Ohio.
2. "Fuel Gas and Incandescent Gas Lighting," by Edward Lindsley, Cleveland, Ohio.
3. "Gas Monopoly," by W. W. Cantine, Alliance, Ohio.
4. "A Holder-Tank Problem," by Geo. H. Tayler, Warren, Ohio.
5. "Oil as a Fuel under Boilers," by J W. Gwynn, Bucyrus, Ohio.
6. "Carbureted Water Gas and its Advantages over Coal Gas," by Chas. R. Faben, Jr., Toledo, Ohio.
7. "The Lowest Price at which Gas can be Profitably Sold in Small Towns," by H. L. Hurlburt, Oberlin, Ohio.
8. "Fuel Gas: Results of Experience in its Manufacture, Distribution and Use," by Chas. H. Evans, Jackson, Mich.
9. "The Welsbach Burner as a Commercial Article," by Geo. W. Graeff, Jr., Philadelphia, Pa.
10. "Advantages of a Combined Coal and Water Gas Plant," by Geo. Light, Dayton, Ohio.
11. "Results of the Adoption of Electric Lighting by a Gas Company," by L. A. Strong, Mansfield, Ohio.
12. "Is the Supply of Natural Gas in the Ohio Valley Failing?" by Eugene Printz," Zanesville, Ohio.

In connection with the meeting there will be an exhibit of gas stoves, engines, burners, electric motors and any and all kinds of apparatus and appliances of interest to gas men and the lighting fraternity. A large room close to the place of meeting has been secured for this purpose, aud the interims of the various sessions can be pleasantly and profitably spent in examining this display, which promises to be much more complete and interesting than the one shown at our last annual meeting.

In addition to this exhibit other objects of interest to members and visitors will be found in Mansfield's Electric Street Railway, the Gas Company's electric light works, and their new water gas plant.

The St. James Hotel will be the headquarters of our Association, where very reasonable terms have been secured for members and visitors in attendance at the meeting. The sessions will be held in a suitable hall in the block adjoining the St. James.

All members are again urged to attend this meeting prepared to participate in the discussion of papers read.

Persons eligible to membership, who are not already members, are cordially invited to be present and join our Association. Visitors from other States and Associations will be welcome.

Very respectfully, IRVIN BUTTERWORTH, Secy.

[OFFICIAL NOTICE.]

Second Annual Meeting of the Southwestern Gas Association.

FORT WORTH, TEXAS, Feb. 11, 1889.

The Second Annual Meeting of the South Western Gas Association will be held at Austin, Texas, Tuesday, March 19, 1889. It is earnestly requested that every member of the Association will make arrangements to be there. Matters of importance will come up for consideration, and a full attendance is desired.

There will be several interesting papers presented, and a good time generally is expected.

Austin is a city of especial interest to the fraternity, and in fact to everyone, being the central ray of that effulgent orb known as the Lone Star, Texas.

To those engaged in the gas business in Louisiana, Arkansas, Kansas, Colorado, New Mexico and Texas a cordial invitation is extended to join us and lend their aid and influence in the common cause—mutual improvement. This is not a Texas institution, but is designed to bring the

gas men of the great South West into a union where they can compare experiences which are peculiar to our locality. Don't forget to come.

THOS. D. MILLER, Secy.

BRIEFLY TOLD.

GENERAL HICKENLOOPER COMES OUT IN FAVOR OF THE COMBINATION PLAN.—Last month it was mentioned in the JOURNAL that Mr. Townsend had introduced in the Ohio State Legislature a bill which proposes to confer on the gas companies of that State the right to supply electric light within their respective districts, and it is quite probable that the measure will in due time and process become a law. This fact, of itself, is quite interesting, in that it shows the pronounced drift of sentiment respecting this question in the opinion of Ohio gas makers, where, however, many of the gas companies—possibly 25 per cent. of the total—are now engaged in practically illustrating, with more or less success, the combination plan. But renewed interest attaches to the question from the fact that the presentation of the matter from a legislative aspect has been availed of by General Hickenlooper to show where he stands *now* in regard to the problem. Considering the wide publicity (popular, and deservedly so) that the General enjoys in the Buckeye State, and remembering that his opinions or judgment in regard to anything connected with the artificial lighting industry therein would have the merit that comes to and from one who is thoroughly posted; hence, being valuable to obtain, it is not strange that he should be asked by one or more of the reigning legislators about his views on the Townsend bill. He was asked the question, in reply to which he prepared one of his characteristic letters, and the same eventually found its way to the columns of the Cincinnati *Commercial Gazette*. Perhaps before going any further into the details of the General's communication it might be well to mention that the Townsend bill merely permits the Ohio gas companies to engage in the supply of electricity under the "terms, conditions and legal restrictions that are now granted and imposed upon existing electric light companies." In other words, all that is asked is a free field, without favor; which, by the way, is all that the average gas man ever asks. To come back to the General's opinions. The letter first speaks of the footing obtained by electricity as a lighting agent and as a source of power, in both of which instances the writer admits that a standing has been secured, and that the possibilities for a wider range in these are great. He then reviews the many and inefficient (all unprofitable) attempts of more or less irresponsible parties and companies to carry on the supply of electric currents in Cincinnati. His *resume* of these is particularly interesting, but does not impress one with an idea of the large profits that have so far been reaped by the *shareholders* in the various concerns. For example, the gross income of the Brush Electric Light Company for the past 5 years (organized in 1883) is shown to have been: 1884, $92,888; '85, $58,960; '86, $57,680; '87, $49,114; '88, $46,876.69—which shows that competition and all that it entails cut the gross income about 50 per cent., while the working expense was, in the aggregate, cut not to exceed 20 per cent., despite all the glowing reports that we are treated to by the electricians concerning the grand advance that is daily, if not hourly, being made in the cheapening of methods of supply and distribution. Going on with his subject, the General reviews the dangers to property and person, and the impossibility of receiving any compensation therefor, which arise from intrusting the supply of electricity to irresponsible parties, and combats the objection to permitting the gas companies to enter the field, on the score urged by some that the latter would speedily monopolize the industry to the injury of those already in the field, by explaining that the public having an undoubted right to choose for themselves, would naturally favor the supplier that rendered them the best service at the lowest charge. This brings him to cite the advantages inherent to the gas company as a supplier of electricity over the company that essays to try the task independently. In evidence he speaks as follows:

"A careful examination of the annual report of one of the most economically conducted incandescent electric light stations in the State, which has succeeded in realizing a profit of about 6 per cent. on its invested capital, shows that its running expenses may be properly classified as follows:

	Per Cent.
Labor and superintendence	25
Fuel	20
Lamp renewals	15
Rent	7
Oil, waste, water and insurance	11
Repairs	8
Office expenses, freight, etc	8
Unclassified expense	6

"The following represents the proportionate detailed expense of operating an arc plant—one of the best and most economically managed in this vicinity:

	Per Cent.
Labor and superintendence	51
Fuel	20
Carbon renewals	6
Rent	15
Oil, waste, water and insurance	4
Repairs	2
Office expenses	2

"And this the detailed expense of another similarly situated:

	Per Cent.
Labor and superintendence	38
Fuel	25
Carbons	11
Rent	15
Oil, waste, water and insurance	4
Office expenses	2

Having shown the advantages that a gas company would have over the independent operator in respect to many of the above items, and mentioning the Cincinnati Company in particular, the General sums up his belief in the following:

"I think I am, therefore, safe in assuming that the Cincinnati Gas Company can operate an electric light station at an expense 33 per cent. less than can an independent organization. While they are doing but little if any better than paying running expenses, we can supply this character of light to the public at lower rates than they are now paying and make a manufacturer's profit."

From the tenor of the General's presentation of the case we infer that it will not be long ere the Cincinnati Gas Company will be engaged in the supply of electric currents, and reaping, in consequence, that "manufacturer's profit." Knowing that Cincinnati gas shares are selling well above 100 per cent. over their par value, we understand thoroughly that the additional profit is not an absolute requisite to its financial strength, and prepares us for the paragraph in the General's letter that reads:

"I am not controlled in my views by any consideration or fear of rivalry to the prejudice of the gas industry, for it has too long occupied the field of artificial illumination, and is now second only in commercial importance and as a field of financial investment to the railroads; and with its invested capital of 500 millions is not likely to fear any honorable competition in the sphere of its labors and usefulness, and in which it is still making rapid growth."

MR. L. P. GEROULD, having been appointed manager of the gas works at Mendota, Ills., signalized his accession to power by announcing a reduction in gas rates, the concession to take effect on quantities consumed since the first inst. The gross rate is placed at $2 per M., with discounts for prompt payment, as appended:

Monthly Consumption.	Net Rate.
1,000 cubic feet	$1.50
3,000 " "	1.40
5,000 " "	1.30

As the annual sendout from the Mendota works is not over 3 millions cubic feet, we incline to the view that the Geroulds (father and son) mean to tell a different story hereafter; and the proprietor (Mr. S. A. Foley) is not the one to say them "nay," as the record of another of his properties (Lincoln, Ills.) conclusively proves. We are glad to say that Mr. Gerould is enjoying good health.

AT the annual meeting of the Boston Company no other business than the reception and acceptance of Treasurer Greenough's report was transacted. The meeting was adjourned to the 25th inst., on which date it is presumed the Bay State Company will name the officers for the ensuing year.

On January 9, 1884, Mr. T. A. Edison said to a *World* reporter: "As soon as we begin operations the gas companies howl. It has been so in this city [New York] where, I venture to say, within five years we shall furnish 98 per cent. of the light." Now that the allotted time has expired, we might remark that the increase in amount of gas sold in this city in 1888 over that sold in 1884 was at least 30 per cent. In the meantime, Edison's "down-town station" has just managed to stand by its anchor.

Continued from p. 273.

[Official Report—Revised by the Secretary.]

Nineteenth Annual Meeting, New England Association of Gas Engineers.

Held at Young's Hotel, Boston, Mass., February 20 and 21, 1889.

First Day—Wednesday, Feb. 20—Afternoon Session.

On reassembling the President introduced Dr. Lewis M. Norton, of the Massachusetts Institute of Technology, who delivered the following lecture on

THE COMPOSITION OF BOSTON GAS.

It is announced on the programme that I am to speak this afternoon on the "Composition of Boston Gas," but what I have to say will relate more especially to the character and effect of the illuminants present in coal gas. My own experiments in this direction have been mostly confined to the Boston gas, and, therefore, any new figures which I may be able to give you will relate especially to the composition of the gas of this city. I propose, however, not to confine myself to that, but to discuss the general subject of the illuminants, their character, and their office.

Common coal gas consists of two distinct classes of bodies—the illuminants, or light givers, and the diluents, or light bearers. These diluents consist of certain combustible carbon compounds, and hydrogen, which, in burning influence the temperature of the flame, but have comparatively little illuminating power in themselves. It has been held that these added very little to the light of the flame, but some late experiments tend to show that one of them, marsh gas (which has always been classed among the diluents rather than among the illuminants) is capable of furnishing a certain amount of light; so that, while it is properly a diluent, it also properly belongs, to a certain degree at least, among the illuminants. The diluents constitute a greater part of the volume of gas; while the illuminants, in volume, are comparatively small, in most cases not exceeding 6.5 per cent. of the total volume of the gas. I think that the analyses by the State Gas Inspector of Massachusetts, so far as they are confined to coal gas, very seldom show above 6.5 per cent. of illuminants. It would seem that the attention of gas chemists would have been directed to the examination of the bodies classed under the heads of illuminants, but the study of the literature relating to gas shows that the difficulties connected with this question have generally deterred examiners from anything more than an estimation of the total volume of the illuminants. Most of the chemists who have had to deal with the question of gas analysis have confined their attention solely to this one subject—the estimation of the volume—and have paid very little attention indeed to the character of that volume. That is due to several reasons. The problem is one of great difficulty. The amount present of certain of these illuminants is so small that it makes their estimation with anything like exactness a very difficult matter; and that reason has usually deterred investigators from attempting anything of this kind. Then, again, they vary in different gases to a certain extent, so that you cannot be sure what will be present in any given gas. Then, again, they have been very difficult to separate; and in fact only in a few cases has any attempt been made to separate them, and to determine the actual percentage of any one illuminant present in any given sample of gas. The analyst has usually contented himself with the determination of the per cent. of the gas absorbed by strong sulphuric acid; and this quantity is commonly known as the percentage of illuminants. The assumption sometimes made that two gases, having the same percentage of illuminants and all other constitutents, ought to have the same candle power, does not appear to be borne out by experience, and is erroneous from a theoretical point of view. I have taken the pains to run down the column of illuminants in the report of the State Gas Inspector, and to compare them with the table of candle powers; and I have found that there are variations existing which are not at all explicable. These variations undoubtedly exist on account of the different character of the illuminants in the different gases, and the volume of illuminants is probably a matter of minor importance.

The illuminants present in coal gas consist of ethylene, propylene, acetylene, benzol, toluol, crotonylene, and sometimes pentane and hexane. In the following table you will find the illuminants placed together, and also the diluents. (See Table I.)

In this table you will notice that the illuminants as compared with the diluents are all very rich in carbon and poor in hydrogen. That is their general characteristic, as you will observe if you will examine their percentage composition. This is so strongly their characteristic that it has been often said that the value of the illuminants in a gas depended upon the relative percentages of carbon and hydrogen present in them. That is to say, the more carbon and the less hydrogen there is present in the illuminants, the greater will be the illuminating power. There appear to be facts which substantiate that theory to a certain extent. Of the illuminants in this table, all except the last two (pentane and hexane), are commonly present in pure coal gas—gas made from coal alone; and the last two are probably always present in greater or less quantity in gas enriched with naphtha. The pure coal gas contains a very small quantity of the two last illuminants, but you might expect to find them in considerable quantity in gas enriched with naphtha. The same can be said of amylene and hexylene. These two will be present in much larger quantity in gas enriched with naphtha, but will not be found in very considerable quantity in gas made from coal alone.

Table I.—*Certain Constituents of Coal Gas and Naphtha Gas.*

Illuminants.	Symbol.	Carbon.	Hydrogen.	Condition at Ordinary Temperature
Ethylene	C_2H_4	85.71 per ct.	14.29 per ct.	Gas.
Propylene	C_3H_6	85.71 "	14.29 "	Gas.
Amylene	C_5H_{10}	85.71 "	14.29 "	Liquid.
Hexylene	C_6H_{12}	85.71 "	14.29 "	Liquid.
Crotonylene	C_4H_6	88.80 "	11.20 "	Liquid.
Acetylene	C_2H_2	92.30 "	7.70 "	Gas.
Benzol	C_6H_6	92.30 "	7.70 "	Liquid.
Toluol	C_7H_8	91.30 "	8.70 "	Liquid.
Pentane	C_5H_{12}	83.33 "	16.67 "	Liquid.
Hexane	C_6H_{14}	83.72 "	16.28 "	Liquid.
Diluents.				
Marsh gas	CH_4	75.00 "	25.00 "	Gas.
Ethane	C_2H_6	80.00 "	20.00 "	Gas.
Carbonic oxide	CO	42.85 "	.....	Gas.

The hydrocarbon of highest illuminating power, so far investigated, is without question naphthaline. I have not placed naphthaline among the hydrocarbons in this list, because very few investigators have ever been able to find it in coal gas. In spite of the fact that we all know that it is present in tar in large quantity, and in spite of the fact that we often regard the stoppage of gas pipes outside the gas works as due to the deposition of naphthaline, yet investigators who have attempted the analysis and examination of the illuminants of gas, have almost always failed to find naphthaline among them. In the Boston gas every attempt to find it has failed. So I have not classed it among the illuminants in this table. Its percentage composition is higher in carbon than anything that we have here upon this list. Naphthaline contains 93.75 per cent. of carbon, and only 6.25 per cent. of hydrogen. But, if it is true that among the illuminants the value is in proportion to the percentage of carbon present, then the natural inference would be that naphthaline would be the most effective of all the hydrocarbons which we find among the products of the dry distillation of coal which would be likely to pass into the gas. Naphthaline is a very effective illuminant, as is well known. In fact, coal gas has been artifically enriched by naphthaline near the burner.

Coming to those hydrocarbons which I have given upon the list, you will find that the illuminants run from 88.33 up to 92.30 per cent. of carbon. If the supposition is correct that the higher the percentage of carbon the greater the value of the illuminant, then we would from this table judge that the best illuminants to have in gas are benzol and acetylene. That would be the natural supposition if it is to be considered that the percentage of carbon present governs this matter entirely. But fortunately there are very few experiments on record with regard to the exact value as illuminants of these various substances. The experiments which I shall mention are confined entirely to two, benzol and ethylene. Those are the only two with regard to whose effect upon the illuminating power of gas we can be said to know anything at present; and so you can see how exceedingly obscure this subject is. There may be others of as great value present, but those two are the only ones which have been examined. The least valuable of all these would appear to be the pentane and the hexane, judging from these figures. Next to them would follow the ethylene, propylene, amylene and hexylene. According to their percentage composition they each should have equal illuminating power; but that is probably not the fact, as it is likely that the constitution and complexity of the molecules has considerable to do with this matter.

Judging from this list the most advantageous substance to have present in illuminating gas would be the benzol. That would be the judgment you would naturally form in looking over this list. Benzol is seldom if ever absent from illuminating gas made from coal. It appears to have been first discovered in illuminating gas by Faraday; and he discovered it by subjecting a large volume of gas to cold and pressure, and succeeded in that way in causing the condensation of the benzol. It was afterward identified by Pitschke, in 1856. You will find from the books that the credit for the discovery of benzol is usually given to Berthelot, who obtained it from illuminating gas in 1876. Up to that time, as you will find in old books relating to gas, allusion is made to the presence of ethylene, rather than to the presence of benzol as the important illuminant. Berthelot, in 1876, in the course of his investigations into the composition of Paris gas, found from 3 to 3.5 per cent. of benzol vapor by volume in the gas. Since that time chemists have more and more inclined to the view that this is the most im-

portant substance present in gas, so far as its illuminating power is concerned. It appears to be always accompanied by a small quantity of toluol.

Crotonylene, which is placed here among the illuminants, was first found in illuminating gas by Caventou, in 1873; and as it is almost invariably formed by the action of heat on petroleum naphthas it is probable that in coal gas enriched by naphtha this illuminant plays a very important part. As naphtha has been freely used in this country for enriching, and as the investigations of gas have been largely made in other countries, you will find that in a great many analyses crotonylene is not mentioned, or, if found at all, it is found in very small quantity; but it is present in our gases here, which are enriched with naphtha, and in very much larger quantity, and it occupies an important position among the illuminants.

Hexylene and amylene may also reach illuminating gas from the same source—naphtha—and may reach it from the coal, to a very slight extent.

The examination of the character of illuminants by the ordinary method of gas analysis is entirely out of the question, on account of the minute quantities of certain substances present. Ordinary methods of analyzing gas simply determine, and are capable of determining only the total percentage of illuminants, and if anything is to be found out about their character some other method must be used. In fact Treadwell and Stokes have lately pronounced it impossible to determine the percentage of benzol present in illuminating gas by any method of gas analysis.

The methods in use may give an approximation, but nothing more. The use of any of the ordinary methods of gas analysis in determining the percentage of these elements seemed to me so uncertain that when I decided to make an investigation of the illuminants in the Boston gas I cut entirely loose from them, and dealt with a larger volume of gas. I used the absorption method, as being one which would remove the illuminants as far as possible from the gas, and place them in such condition, or so fix them, that I could investigate them; and I did not rely at all upon the ordinary methods of gas analysis, which I have found are very inaccurate when applied to an investigation of this kind.

In turning my attention to the Boston gas, and in studying its illuminants, the first that I investigated were ethylene and propylene. The amount of these present in gas can be determined with a tolerable degree of accuracy and without a very great deal of effort. The substances were absorbed from illuminating gas by means of bromine, with which they combine with great ease, and then these bromides were examined. After the bromides had been separated and their weights taken, then the percentage of ethylene in the gas originally was calculated from the weight of bromide obtained. I used in these experiments from 15 to 25 cubic feet of gas, which is a very different thing from dealing with the necessarily small quantities used in the ordinary methods of gas analysis, and it insures very much greater accuracy in detecting the presence of a small quantity of any constituent. The bromides obtained by the union of the bromine with the gases were distilled in vacuo, and fractionated, and, after analysis, the per cent. of the substances in the original volume calculated. The liquid bromides of ethylene and propylene left upon distillation in vacuo a solid residue, which was purified by crystallization, and found to consist of crotonylene-tetrabromide and dibrombenzol. These were separated by crystallization and examined.

When it came to the question of determining the percentage of benzol present, then we had to have recourse to entirely different methods. We could not absorb benzol entirely by bromine. A certain proportion of it was absorbed, but by no means the whole. So we attempted to determine the percentage of benzol in the Boston gas by the absorption of benzol with nitric acid. That is an old method which has been used to a certain extent. In fact it is one of the patented methods of utilizing the benzol in illuminating gas. We found that in passing illuminating gas through nitric acid that not only was the benzol taken up, but also other illuminants, such as hexylene and amylene, combined with nitric acid, giving us a product from which we could not separate the nitrobenzol. So we were not able in that way to determine the per cent. We had to have recourse to an entirely different method for the absorption of the benzol from the gas. We used a method suggested first by Dittmar—that of passing the gas through olive oil. If ordinary illuminating gas is passed through olive oil, or a heavy tar oil, or a heavy petroleum oil, these oils will remove from the gas the illuminants which would be liquids at ordinary temperatures. In the table presented I have given the physical condition of the various illuminants at the ordinary temperature, and you will observe that only three of them are gases at ordinary temperature, the others being liquids. Those that are liquid are present in ordinary gas simply in the form of vapor disseminated through it. For the purpose of removing the benzol I used olive oil, which seemed to work with perfect ease. I passed the gas through the olive oil, and then heated the oil with steam, drove out the liquid hydrocarbons, condensed and examined them. Having heated the oil, and passed steam through it, the steam carried over the liquids absorbed from the gas; and after condensing the vapors we separated the hydrocarbons from the water. They consisted mainly of benzol and toluol. The olive oil probably absorbed the crotonylene also, but on account of its extreme volatility we were unable to condense it when the oil was treated with steam.

Acetylene has sometimes been regarded as an important constituent of coal gas. It was discovered in coal gas by Berthelot, and has been found by some others. Berthelot founds upon the fact an elaborate theory regarding the formation of benzol in the retort. To determine the amount of acetylene we passed the gas through subchloride of copper solution, which absorbs it readily, then filtered off the red precipitate containing the acetylene; decomposed this with hydrochloric acid, absorbed the acetylene in bromine, and weighed the tetrabromide found. We found that the percentage of acetylene was extremely small, amounting to not more than 0.1 to 0.05 of one per cent. of the volume of the gas. So that it may almost be left out of consideration in determining the illuminating power of the gas. It was present in extremely minute quantities in the several samples that we examined.

Naphthaline was found in illuminating gas by Pitschke, who passed illuminating gas through alcohol, in which naphthaline is very soluble, and in the alcohol he discovered a quantity of naphthaline. We tried this same process on the Boston gas. We passed some 35 cubic feet through alcohol, and then examined the alcohol, but it did not contain the slightest trace of naphthaline. We then tried to remove it by means of heavy petroleum naphtha, but did not succeed in obtaining a trace of it. We then had recourse to cold and pressure, and subjected the gas, under a pressure of five atmospheres, to a tempearture of 9° above zero, F. We only succeeded in condensing liquid hydrocarbons. In one case only in the solids obtained by the action of bromine upon the gas did we find a small quantity of a substance which may have been dibromnaphthaline. So that, in spite of our endeavors, we did not succeed in proving the presence of naphthaline in the Boston gas; and I doubt if at the time we made this examination it was present in the Boston gas. We thought it possible that it might have been taken up by the water in the wet meter that we were using; but an examination failed to yield the faintest trace of it. Therefore I think that the gas was practically free from it at that time at the place from which we took our samples.

As to the other constituents of the gas, we did not examine them with any special care; the usual Hempel process described this morning was employed. In the first column of Table II. the percentages obtained are to be found. You will notice the extremely high percentage of nitrogen, which is very much higher than that usually found in Boston gas. This is a mean of several analyses which gave very good check results. I think it is fair to say that in all probability it was in the gas just at the time we happened to examine it; and yet I am of the opinion that the Hempel apparatus is inclined to yield higher figures in nitrogen than would be obtained by the use of such an apparatus as is used by the State Gas Inspector. I have found in examining other gases with the Hempel apparatus that the figures obtained for nitrogen were uniformly higher than those furnished by the Dayere apparatus.

I present here a table containing all the analyses of coal gas which I have been able to find in print. It seems to be a small number indeed. You will notice that there are only six which approach completion; but these are all that I have found in literature in which the constituents of gas have been determined with any accuracy, or with anything like completeness. It may be that there are other investigations to be found in the records of the various gas works; but I think they have not been put into print, for I have examined into this question with very great care. You will see that this table comprises one analysis of Boston gas, one analysis of Konigsberg gas, one of Heidelberg gas, two of Hanover gas, one of Manchester gas, and a partial analysis of Paris gas. The figures in column VI. (Manchester gas) give the determinations made by Mr. George E. Davis. Those figures are calculated from his results. He presents his figures in an entirely different form; and in order to bring them into line with other figures which I have presented here, I have been obliged to recalculate his results.

TABLE II.—*Analysis of Coal Gas, in Volume per Cent.*

	I.	II.	III.	IV.	V.	VI.	VII.
Ethylene	2.30	2.01	2.55	2.48	2.11	2.24	0.1–0.2
Propylene	0.73	0.72	1.21	0.64	0.37	....	0.02
Benzol	0.83	0.66	0.69	0.59	0.69	2.00	3.0—3.5
Acetylene, Crotonylene, etc.	2.17	.....	.....	.....	.....	.....	0.1
Carbonic acid	0.12	1.40	3.01	0.48	0.81	2.94	.....
Carbonic oxide	6.08	4.00	8.88	7.42	11.19	6.00	.....
Marsh gas	42.32	35.28	34.02	38.75	46.27	41.50	.....
Hydrogen	35.35	52.75	46.20	47.60	37.55	45.70	.....
Oxygen	0.12	.....	.....	0.02	.....	.....	.....
Nitrogen	9.98	3.18	2.15	2.02	1.01	.....	.....
Specific gravity	0.41	0.37	.....	.....	.....	.....	.....

I.—Boston gas, by Norton and Doolittle. II.—Konigsberg gas, by Blochmann. III.—Heidelberg gas, by Kinnicutt and Treadwell. IV. and V.—Hanover gas, by Fischer. VI.—Manchester (Eng.) gas, by Davis. VII.—Paris gas by Berthelot.

So far as I am able to learn, these samples are all pure coal gas, with the exception of the Boston gas, which is enriched by naphtha. It will be observed from the table that in general the percentage of ethylene remains nearly constant, from 2.01 to 2.55 being unusally present. The quantity of propylene varies within somewhat wider limits. It seems to have been absent from the Manchester gas at the time this analysis was made; but in other gases it varies from 0.72 to 1.21. When we come to the quantity of the benzol, we find that it undergoes even larger variations. Leaving out of the case the Paris figures, the benzol varies from 0.59 to 2.00 per cent. That is a very large variation indeed, and yet, there is a general tendency towards three-quarters of one per cent.

Besides these illuminants, the Boston gas which I examined contained other illuminants, consisting of acetylene, a considerable amount of crotonylene, and small quantities of hexylene and amylene, making up some 2.17 per cent. of the total volume of illuminants. That is a very exceptional thing. Among these gases which I have placed in this table the Boston gas is the only one that is enriched by naphtha; and this peculiarity in the illuminants in the case of this gas is undoubtedly due to the use of naphtha in enriching. It changes the character of the illuminants to a considerable extent.

In regard to the other constituents I hardly need to speak at all. It is greatly to be regretted that in preserving these analyses the makers of the analyses have not stated the candle power of the gases. I do not know the relation of the percentage of illuminants in these gases to candle power; as it was not preserved by the persons who made the analyses, or at least not put on record by them, and I am unable to give you any figures that they may have made. The figures given by Berthelot upon the Paris gas, in column VII., are very peculiar. They show a gas in which the sum total of the illuminants is practically benzol. There is very little else. That was found in several other analyses of Paris gas made about that time. It is a very peculiar state of things which has never been observed in any other gas. In fact it was so peculiar that it was doubted by almost all the other investigators of gas, who scouted the idea that there was anything like three per cent. of benzol vapor present in the Paris gas. But on the whole I think that Berthelot has sustained his point.

The question which we would ask with regard to these illuminants present in the gas, and the one of the greatest practical importance, is of course their relation to its illuminating power—to its light giving power. In other words, how much of the illuminating power is due to the presence of one constituent, and how much to the presence of another? In order to gain some information upon this point we subjected the gas which we had under examination to the action of olive oil to remove its liquid constituents, and then took the candle power of it to determine the loss in candle power caused by such removal. The mean of a number of estimates of candle power, before the gas was passed through olive oil, was 18.27; and after the gas had been passed through olive oil the illuminating power was 7.03 candles; showing that the liquid hydrocarbons, and the vapors which we had removed from the gas by passing it through the oil in this way, raised the candle power from 7.03 to 18.27. This is a very striking reduction. It has never been found that this oil would absorb gaseous illuminants at all; and it is doubtful if it would take up more than a trace of the propylene; but the liquid compounds are thoroughly removed.

Some similar results have been obtained by others, but this is perhaps as striking as any of them. It shows that the removal of the substances which were in the form of vapor, and not as fixed gases, lowered the candle power from 18 to 7. So that you see that in such a gas the main reliance for illumination is upon the vapors of liquids which are present in it, and not upon the fixed gases themselves. It appears that 61.6 per cent. of the illuminating power was removed by extracting the compounds that were soluble in oil.

The illuminating value of the various illuminants unfortunately has not been determined, as I have said, except in the cases of benzol and ethylene. Knoblauch made experiments several years ago, and found that the illuminating value of benzol vapor was about six times that of ethylene; and P. F. Frankland repeated the same experiments, at a later date, and obtained practically the same results. The result arrived at by these two investigators was that one volume of benzol vapor was equal, in round numbers, to six volumes of ethylene as an illuminant. In other words, that 6 per cent. of ethylene in a gas was necessary to do the work which would be done by one per cent. of benzol vapor. The candle power of pure ethylene, burned at the rate of five feet per hour in a standard burner, was determined by Frankland and found to be 68.5 candles. Figured upon that basis the candle power of benzol vapor, burned under similar circumstances, would be 411.0 candle power. So that you can readily see that the infusion of a very minute quantity of benzol vapor into the volume of an illuminating gas is sufficient to make an enormous difference in its illuminating power.

Frankland found further that a mixture of marsh gas and hydrogen must have 13.4 per cent. of ethylene added to it to reach 16.8 candles, while 3.09 per cent. of benzol vapor gave a candle power of 22.9 candles. That is, if you were making an illuminating gas, the body of the gas consisting of marsh gas and hydrogen, you would have to put in 13.4 per cent. of what is ordinarily called illuminants, if it was ethylene alone, to reach a candle power of 16.8. That would be a figure very far beyond anything found in ordinary illuminating gas. Still, he found that 3.09 per cent. of benzol vapor gave a candle power of 22.9. From this you see the enormous advantage of benzol vapor over ethylene; and these figures show very strikingly the difference in value of those two illuminants.

This difference, however, becomes very much less if you look at this whole question from another point of view. That is the point of view of *weight*. If you examine into this question of advantage from the point of view of weight you will be surprised at the results that you will obtain. Calculated upon the basis of percentage by weight, benzol vapor has only about 2.1 times the value of ethylene; while calculated by volume it has about six times. So that the question of weight comes in here very seriously.

It is to be regretted that no figures exist regarding the effect of propylene, acetylene and crotonylene as illuminants. There is a prevailing opinion that these compounds all have a much greater effect than ethylene, but I am unable to find that it is founded upon any experiments. There is an opinion that amylene and hexylene are still more effective, but there seem to be no figures upon which that opinion can be based. In fact, the candle power of these other substances in the form of vapor gases have never been determined as far as I am able to learn. It can be safely asserted, I think, that benzol is the most valuable of all the illuminants, and its presence is to be desired in illuminating gas in the largest quantity which will not cause inconvenience by condensation in the pipes—that is, as much as will remain in the form of a permanent vapor in cold weather is desirable in gas. It appears from the experiments that we have made that it is one of the most desirable substances that can be put in. You are probably aware that Davis, at a time when benzol commanded a higher price than at present, proposed to remove it from gas entirely, and if necessary replace it by other and cheaper illuminants. He proposed a variety of methods for carrying this out. In the course of his investigations he examined the illuminants which were present in the gas made by certain private works, and separated the different substances. He used sufficient gas to obtain about two quarts of all the liquids. He found that of all the liquids obtained from the gas about 75 per cent. was benzol. Now, while the percentages of illuminants in ordinary illuminating gas are very small looked at from the point of view of volume (usually not exceeding 6.5 per cent), on the other hand, if you take those percentages and recalculate them into weight, you will reach some striking results. These substances which are present in gas as illuminants are very much heavier than the other bodies which go to make up the volume of the gas; and when they are calculated into weight percentages, the illuminants in gas which seem insignificant in the case of volumes, rise to figures which are considerably significant in the case of weight. I have recalculated my own analysis of the Boston gas on the basis of weight, and have obtained the following percentages by weight:

Ethylene	5.4
Propylene	2.5
Benzol	5.4
Carbonic oxide	14.1
Hydrogen	5.9
Marsh gas	57.2

A comparison of these figures with those already given show some very striking differences.

I have recalculated the Blochmann analysis of the Konigsberg gas in the same way, and with this result:

Ethylene	5.1
Propylene	2.7
Benzol	4.7
Carbonic oxide	22.7
Hydrogen	9.7
Marsh gas	51.7

The only other one in which the data necessary for recalculation were at hand was the analysis of the Manchester gas, by Davis, which yields following result:

Ethylene	5.0
Propylene	
Benzol	12.5
Carbonic oxide	13.0
Hydrogen	7.1
Marsh gas	52.0

Now, while we have to deal with only 6.5 per cent. of volume of illuminants, upon the different basis of weight percentages, the illuminants run from 12.5 up to 17.5 per cent. Looked at from the point of view of weight, they cease to be so insignificant as when we look at them from the point of view of volume. They really constitute, judging from the point of view of weight, a very considerable portion of the gas; and we can readily see why

their presence is of so much importance. It would seem, therefore, that, taking benzol alone, three per cent. by volume would give a great increase of illumination; whereas with three per cent. by weight we would get comparitively little light; but in the case of Paris gas, if it could be refigured upon such a basis as I have used with the others, we would very likely have 15 per cent. of benzol vapor, and possibly even more—showing that the weight is, after all, the essential thing in these illuminants, and that the illuminating power depends upon the weight of the illuminants to a greater degree than upon their volume. It might well happen that two gases, for example, would yield upon analysis six per cent. of illuminants. If the six per cent. of one gas was ethylene, and the six per cent. of the other gas was a mixture of ethylene and benzol, the weight per cents. would vary very largely. So that you would find in that way that the analysis in volume per cents. gave very little idea of the candle power; but if figured in weight per cents. the difference between two such gases would be apparent. So that the expression by volume per cents. is, from this point of view, quite deceptive.

The proportion of the total benzol, which is formed in the distillation of coal, which passes into the tar is a somewhat interesting question. The amount of benzol which passes into the tar is relatively small, while the proportion of toluol is much greater. I subjected a sample of the Boston tar to distillation, and found that I was able to get 0.39 per cent. of benzol; the per cent. of toluol was about the same, and that of xylol a little less. In round numbers I suppose that the tar would have yielded 1 per cent. of 50 per cent. benzol.

I have taken the amount of benzol that I found in the gas and compared with it the amount that goes into the tar. I do not know whether you will be surprised, but I was surprised at the very small proportion of benzol that passed into the tar—nearly all of it remaining in the gas. I made a calculation upon the basis of 4.5 per cent. of tar and 9,000 cubic feet of gas to the ton of 2,000 pounds. I think that is not an excessive amount of gas to the ton of coal carbonized. Figuring upon this basis I found that from a ton of coal about one-half of one pound of benzol would pass into the tar, and 16 pounds of benzol into the gas; that is to say, about 32 times as much benzol went into gas as went into the tar. I have found that those figures agree approximately and somewhat closely with the figures obtained in Paris during the ten years from 1876 to 1886, where the conclusion was reached that about one twenty-fourth of the benzol went into tar, and that about twenty-three twenty-fourths went into the gas. I had always believed until I made these figures that a considerable portion of benzol was condensed and passed into the tar; but this calculation, which I think is approximately correct, will show you that that is not the case, but that the most of the benzol passes into the gas, and that very little goes into the tar. And that makes explicable, perhaps, the number of patents that have been taken out for processes of removing benzol from gas—using the gas as a source of benzol rather than the tar, because it is evident that most of the benzol has gone into the gas; and therefore, if you wish to get benzol, that is the place to look for it. Davis took out a number of patents and placed several plants in operation in England a few years ago, when the price of benzol was high. His plan was to take the benzol from the gas and then enrich the gas again; but at the present low price for benzol it is found that this process does not pay. However, if the price of benzol ever goes up again the gas is the place to look for it, and not the tar.

There is one other point of view which is important in considering this question, and that is in the matter of enrichers. If the benzol is the most valuable of the elements, and if ethylene and propylene are subordinate in value, what is the best enricher to use to bring up the candle power of gas? It is unfortunate that we have not here a great many experiments to guide us. I suppose that in this State, and perhaps in New England, the main enrichers might be said to be cannel, naphtha and residual; and possibly crude oil is used to a certain extent. Those are the four that are generally used. Now, the question arises, which will be the best to use from the point of view of the composition of the illuminants? The cannel is ordinarily sure upon decomposition to furnish some benzol, and also furnish gas of high candle power. In regard to the composition of the gas obtained by heating cannel coal very little, in fact almost nothing appears to be known. A few experiments of my own upon the composition of gas furnished by the decomposition of albertite at a high temperature give all the information that I have been able to gain in this direction, as far as the nature of the illuminants is concerned. The decomposition of albertite at a high temperature gives rise to gas of high candle power. In the experiments which I made I found that it contained about 27 per cent. of illuminants, and its illuminating power was four times that of the Boston gas. The sample that I examined gave upon distillation almost no ethylene; but propylene was present to a very considerable extent, as were also hexylene and amylene. So that under the circumstances in which I heated albertite it gave rise to very little of ethylene and comparatively little benzol, but mainly hydrocarbons of the ethylene type were found, consisting of propylene, hexylene, and those of about that composition and character.

I am sorry I cannot give you any definite figures with reference to the decomposition of cannel. It seems to me if cannel is to be used for an enricher it is a subject that needs careful investigation; and I have not been able to find any data in regard to it. In fact I am uncertain in my own mind whether the decomposition of cannel gives rise to any considerable quantity of benzol or not. Frankland in one of his papers has said that it does not; but I can find no experimental authority for his statement.

Naphtha is used as an enricher to a very great extent; but naphtha is of necessity somewhat uncertain in its action. It has been shown that at a moderate rate of heat naphtha furnishes very little benzol—very little indeed. The hydrocarbons of the benzol series are hardly formed at all by the decomposition of naphtha at ordinary high heats. That is a subject upon which I have made a somewhat prolonged investigation; and the question has been investigated also by others. It seems to be conceded that the amount of benzol that can be obtained from naphtha is very small. On the other hand, naphtha furnishes ethylene and propylene very easily, and begins to furnish them at very low heats, and as the heat rises furnishes them even more readily; so that the gain that comes from the use of naphtha as an enricher I am justified in saying will consist very largely in the ethylene obtained from it. It furnishes other illuminants, as hexylene and amylene also. There are a number of patented processes for obtaining benzol from naphtha, but thus far the effort has been attended with entire failure. The thing does not appear to be practicable.

With regard to the use of heavy oils, such as residuum and crude oil, I may say that there is doubtless more benzol produced in the decomposition of residuum than in that of naphtha. The only experiments which bear upon this would seem to relate especially to the residuum of Russian petroleum. Unfortunately the Russian petroleum contains compounds belonging to the benzol class; so that the results of these experiments are not as definite as we might wish. A considerable yield of benzol was obtained from the decomposition of residuum—a considerably greater yield than can be obtained from naphtha.

Tar has been recommended as an enricher, perhaps on the ground that it contained benzol. Tar undoubtedly does contain a very considerable percentage of hydrocarbons belonging to the benzol series, and these compounds upon decomposition give rise to benzol. The amount of such compounds is perhaps 12 to 15 per cent. of the total weight of the tar; so it is conceivable that, by a proper use of the tar, a gas of high candle power, containing benzol, might be obtained, but the volume would not be large. Some have thought that tar contained a great amount of benzol which could be had by simply heating the tar. But that is not so. The tar must be heated to a point at which these other compounds present in it are decomposed, before any large percentage of benzol or gas of high illuminating power can be obtained.

Now, in relation to the different illuminants there is one other question to be considered, and that is the influence of the diluents upon them. It may be that such is the nature of ethylene that although it adds but little to the candle power, yet if it is diluted with carbonic oxide the effect of the dilution with carbonic oxide might not be as serious upon it as it is upon the benzol vapor, for example. That is, the character of the diluent might have a great deal to do with the actual amount of light which these various illuminants would furnish in the gas. In regard to the effect of various diluents upon these gases there are very few experiments.

In regard to the character of the diluents, and the relative effect of the various diluents upon gas, there are quite valuable experiments by Mr. Hinman, of this city, which are to be found in one or two of his reports, and we must depend for our information in this matter upon the work of Messrs. Frankland and Hinman.

There is another peculiar fact in relation to enriching with naphtha which it is worth mentioning. Mr. Moore, in his investigation into the character of the Granger water gas, found in his analyses, which were made upon water gas made at Worcester, Mass., and in another sample which he examined, a considerable percentage of benzol. He found from 1.5 to 2.6 volume per cent. of benzol vapor formed by the heating of the water gas and naphtha vapor together. I have said that I found it practically impossible to obtain any such percentage of benzol by the decomposition of naphtha; but it is not impossible that this result may be obtained when naphtha gas vapors are heated together with water gas, as in the Granger process. So that while naphtha directly may not furnish benzol with any ease at all, yet if heated with a certain amount of water gas, the result appears to be quite different.

With regard to the question of what heats will produce the largest percentage of benzol—that of course is a question which I am not fitted to answer; but if you are to rely largely upon the percentage of benzol which is present in the gas for the illuminating power then it becomes a very important question to you as to what heats will give you the highest percentage of it. I think of late years the tendency has been to use heats which give the greatest volume of gas, without, perhaps, considering so carefully the illu-

minating power of the gas. I think the tendency has been to produce higher heats constantly, and so increase the volume of gas per ton of coal carbonized. It seems to me that such a principle as that might well injure the gas to a very considerable extent; and it seems to me it is questionable if it would not be better to use lower heats, and obtain in that way somewhat higher illuminating power. That is what I should expect, looking at it from a purely theoretical point of view—that with higher heats less benzol would be present in the gas; and per contra with lower heats I should expect a much greater yield of benzol in the gas. The benzol vapors as soon as formed probably undergo a certain amount of decomposition before they leave the retort. It has been a question whether the benzol was formed inside the retort by the action of the heat upon such vapors as acetylene and ethylene, or whether acetylene was formed by the decomposition of benzol inside of the retort. Both views have been held to a considerable extent, and I believe that both of these are correct, and that both of these reactions take place. My own experiments show that ethylene is converted to a certain extent, at high temperature, into benzol, and experiments also show that benzol at high temperature is converted into acetylene. So that this question of the decomposition of benzol vapor inside the retort is not a very important one. The retort my be giving more benzol vapor from the action of heat upon the ethylene, or it may be decomposing benzol, and giving less. It is impossible to say, as no one knows anything with regard to the temperature at which these reactions take place.

I shall be glad to answer any questions with regard to this matter, if I can answer them; and I shall be very glad to get information with regard to illuminants, and their character, now, or at any time, from members of this Association. I propose to investigate this question more carefully as I may find leisure for it.

Discussion.

Mr. Lansden—I would like to ask Dr. Norton the percentage by weight of the illuminants in coal gas.

Dr. Norton—If you add up the weights given, you will have 13.3 per cent. by weight in the gas—that might be very different in another gas—it would depend entirely upon the character of the illuminants; but in this case there are 6.3 by volume and 13.3 by weight.

Mr. Lansden—That, as I understand, is in the case of gas enriched by naphtha?

Dr. Norton—Yes. The highest figure is 17.5, in the case of gas which practically contained benzol and ethylene.

Mr. Learned—In speaking of the illuminants which he absorbed by oil, he said that the gas after passing the oil was about 7-candle power. Where do the illuminants in that gas come from?

Dr. Norton—From the ethylene and propylene which are not absorbed by oil; probably also slightly from the marsh gas—for marsh gas is not entirely without illuminating power.

Mr. Learned—You say that low heats are conducive to the benzol series; and at the same time, if I understood you correctly, you say that it is only from high heats that you can get benzol. What I want to get at is this: In my own practical experience I find that on a yield of 5¼ I get as good candle power as I do on a yield of 5 feet. Now, why is that? I distill my tar and find very little light oils in it. I take the analyses of the gas, as made by the State Inspector at different times, and find a slight increase of hydrogen, a slight increase of carbonic oxide, also a slight decrease in marsh gas; but one of the queerest things is that my illuminants are very small—amounting to only about 4.3 per cent.; while I find, by comparison with these other gases, that *they* contain about 6 per cent. of illuminants. Why is it? I run high heats, and yet I get that change. I have faith to believe that the analyses are nearly correct, from a comparative point of view, because they all seem to agree. Now, am I right in running these high heats? I believe I am, for the very reason that it comes right down to the question of the production of those illuminants; and it seems to me that with those high heats I get an increased quality of illuminants—more than other people do in ordinary heats. Am I right in that?

Dr. Norton—What do you use as an enricher?

Mr. Learned—Lima oil—not the natural oil, it is the residuum, the lighter oils having all been taken out.

Dr. Norton—You use what, to my mind, is one of the very best enrichers. I said that that was a question about which I had no practical knowledge; but it would seem to me that at too high temperature there would be a liability to split up the benzol and so show a decrease in the percentage of it.

Mr. Learned—I thought that by splitting up the hydrogen and carbon compounds I made other compounds, which added to the quantity of my illuminants. There is one thing that I got right lately in relation to benzol in my gas, and that is that I have noticed that there has been in the neighborhood of 3 per cent. by volume of benzol.

Dr. Norton—I gave one result of that kind, showing about 2 per cent. in the Manchester gas.

Mr. Jones—Has Professor Norton ever examined common coal tar for benzol—I mean that which is made in works where they do not use the regenerative furnace for high heats?

Dr. Norton—I have not.

Mr. Jones—I know that the tar distillers complain of a lack of benzol in the tar made over regenerative furnaces; and they claim that tar containing a large percentage of benzol is the best for saturating their paper and for general uses. It would be interesting to know the difference in percentage of benzol in country tar and the tar made in the regenerative furnaces in Boston.

Dr. Norton—I am obliged to you for the suggestion, and will try to have such an experiment made.

Mr. Lamson—I have heard some talk about the tar made in large cities and the tar made in country towns. I find there is a great deal said in the city about the tar made in country towns, while in the country towns they talk about the tar made in cities. I would like to ask the Professor a question or two about the naphthaline which he found or did not find, in his experiments when he made his analyses of the Boston gas. I think there can be no question but what there must have been a certain percentage of naphthaline in that gas. Probably it was a very small percentage, but without doubt there must have been some. Naphthaline has never troubled us very much in Boston; but I believe under proper conditions you can develop naphthaline in the system at almost any time. At certain times you find quite a considerable amount in various parts of the works, and at other times there is practically almost none. I have no doubt that if any of us went to work we could develop evidence of naphthaline. I have no question that naphthaline must be present in some form or other in the gas. Now, I would like to ask him, as an expert chemist, if some of these other components of the gas would form naphthaline; or whether there were present component parts of naphthaline in some other form?

Dr. Norton—Not after the gas has left the retort.

Mr. Lamson—The naphthaline must be there.

Dr. Norton—I have no question about it in my own mind. When I began the investigation I made experiment after experiment, and in one of them I got something which gave me the idea that there might be a faint trace, but too small to be determined by any of the methods that I could use. You will observe, in going through the analyses which I have presented, that there is no naphthaline found.

Mr. Lamson—What struck me was that you were so positive about it, and everyone else had failed to find any trace of naphthaline, when everyone of the gentlemen present would probably say, if asked, that they believed there was naphthaline present in that gas and in their own gas.

Dr. Norton—I have heard of the closing of pipes by its deposition, and it has seemed to me almost incredible that it should not be present in the gas. I think that Davis found a slight trace of it in the Manchester gas; and Faraday found a slight trace of it, I do not know in what gas; and Fischer found it in the gas which he analyzed. With those three exceptions I think that no one has really found it in analyses of gas.

Mr. Lamson—I believe I can take the gas which the Professor has tested and produce from it evidence of naphthaline. That is, while he is making his analysis I believe that I can demonstrate that there is naphthaline in the gas. I think Boston is very fortunate with regard to the presence of naphthaline in the gas; but I know that there is a certain percentage of it, and it seems to me that in so careful and thorough an analysis some trace of it should have been found.

Dr. Norton—And so it seemed to me.

Mr. Boynton—What, in the Professor's opinion, will be the effect upon these illuminants of passing the gas through a very low temperature; for instance, passing it through a main that is enclosed in frozen ground and condensing frost inside the pipe; and also upon the comparative condensation of his illuminants, which are liquid—whether they would be precipitated faster?

Dr. Norton—There would be condensation in any illuminating gas when subjected to the action of a freezing mixture.

Mr. Boynton—Would the benzol suffer the most?

Dr. Norton—The toluol would suffer most; then benzol; then the hexane; next in order the hexylene; then the pentane and amylene about together.

Mr. Taber—I wish to ask Dr. Norton if he has thought of the varying conditions under which the gas is made—the changes in temperature of the retort and of the stand-pipe—which at first might develop benzol and then disintegrate it. A few years ago I had some figures present of the different temperatures of the stand-pipe during the charge. I have not

got them with me now, but I remember that they varied very essentially during the charge; the temperature of the stand-pipe, which might at one time give off one of these series might at another time give another, and split up the first. Have you ever considered that subject? That is, have you considered that our gases might be entirely different one minute from what they are half an hour later?

Dr. Norton—I have never considered that subject at all, but I can readily see that it might be so, and that it might make a great deal of difference.

Mr. Taber—If that was the case, how would these gases be in the holder? Would they be thoroughly mixed?

Dr. Norton—I should suppose so, but I do not know about that.

Mr. Taber—I have always had the idea that the gases which we make vary essentially almost every moment during the charge. That what we are called on to analyze might be one moment one gas and at another moment another gas, unless the gases were all embraced in the holder, thoroughly mixed up, and an accurate sample taken of the whole.

Mr. White—I was much interested in what the Professor had to say on the subject of benzol in the tar. Some years ago I gave a great deal of attention to that subject. We were searching for a cheap method of enriching our gas, and Mr. Curley, of Wilmington, Del., had invented a box in which he carried all the liquid products from his hydraulic main, which was heated by a coil of steam pipe, and all the gas from the retorts passed over (not through) the liquid—but simply through under the top of this box, and there was supposed to be mixed with the light hydrocarbon vapors that were supposed to be liberated by hot steam acting upon the tar which had come over from the main. Mr. McIlhenny, of Washington, D. C., noticed that in his works (where the gas was then, as now, subjected to very careful and constant government inspection and analysis) that very soon after adopting this device his gas was showing an unusual quantity of impurities in the way of extra ammonia and sulphur, which he could not account for in any other way than that they were being liberated from the liquid products from the hydraulic main. My relations with Mr. McIlhenny being very close and friendly, we exchanged some letters on the subject; and I commenced, then, at the Citizens works in Brooklyn, N. Y., a very careful investigation of the subject. The idea that there was absolutely no benzol product to be had from the tar taken from the hydraulic main was scouted by everyone that I then consulted with. I extended my investigation to the tar taken at different points throughout the works—from the condenser and also from the final depository, the tar well; but failed under very careful tests to discover any unusual quantity of benzol. I am very much obliged to the Professor, as he now lifts me out of the dilemma I have been in for some years as to whether I was utterly incompetent or ignorant, or whether the gentlemen who were criticising me were ignorant of the facts. I was then satisfied, and have been for years, that we gain nothing whatever in using tar, as we are compelled to use it about our works, in the enrichment of our gas.

Mr. Lansden—In regard to this matter of carbonization, I want to say that I was criticised a few years ago by the English *Journal of Gas Lighting* for a certain remark that I made. I asked the question why it was, when you charged a retort with chunks of coal, that for the first half hour you got twenty candle gas; while at the fourth hour you got ten candle gas. I said I thought that inside that chunk of coal, if you broke it up, you would find as good gas as on the outside. The criticism was if that was so the outside of the coal would show a denser condition than the inside. It appears to me that if any man will examine a piece of coke worked off in four hours he will find that the outside is a great deal more dense than the inside. Therefore, as Mr. Taber speaks of changing conditions all the time, my theory is that, starting from the inside, the illuminants, in passing out through the lump or mass of this material, would be deposited and left behind. In regard to naphthaline I may say that I never heard of it until I commenced using Pittsburg coal. The western coals do not give it. They were not rich enough. As to the difference between country and city tar, I may say I have known the manufacturers of tar paper, after they had saturated several hundred tons of paper with country tar, to use it to build a dyke with—it would not stick together—so that for the purpose of saturating paper they had to send and get the city tar.

Mr. Harbison—I move that the Committee, and Professor Norton, receive a hearty vote of thanks—the Committee for securing such a lecture, and the Professor for delivering it.

(The motion prevailed).

Mr. H. S. Chase (Great Falls, N. H.) followed with a paper detailing some

EXPERIENCES WITH A SPRINGER CUPOLA.

Mr. President and Gentlemen:—In spite of my remonstrance to our most worthy Secretary I find my hastily-written paper forming a part of this meeting's bill of fare. If you will consider it as merely a side dish, an *entree*, perhaps, like the cold pork and apple sauce at the country hotel, and judge it accordingly, I shall feel relieved.

After some two years of investigation the Great Falls Gas Light Company decided last spring to replace its coal benches by a Springer water gas cupola, and that this action may be understood I will give a brief sketch of the circumstances which called for the change.

More than half our total output is consumed in the mills of the Great Falls Manufacturing Company, a corporation which controls one of the finest plants and water privileges in New Hampshire. The total water shed of the Salmon Falls river is subject to this Company's control, giving ample water power, and the corporation under its present efficient management has a financial standing which is high among the cotton mills..

Our 10 and 8-inch mains ran through the yard of this Company on their way to the town, and the mills' draught, when all lights are burning, somewhat affect the town pressure, but not materially. Our output in the heavy season, with dark days and the mills burning all day, often times increases to what may be called a "cold shiver" degree; for formerly, with all retorts running, and our output exceeding our holder capacity by one-half, the crown sheets would not seldom approach alarmingly near the water line. New holders were not at present admissible, and we turned to the cupola as a hopeful solution of our special difficulties. With the cupola we should be as well off in summer as in winter, and a succession of dark days, in June or July even, should no longer have terrors for us. In addition to this prevailing point we desired to reduce the selling price of gas without reducing our profits, and the cupola bid fair to put gas into the holder for us at considerably less cost than we were able to do with our benches. We could doubtless have reset our benches in an improved manner and thereby reduced the cost of coal gas quite a little, but the cupola idea prevailed, and we contracted with the National Gas Light and Fuel Company, of Chicago, on advantageous terms, for a 48-inch, 25-foot cupola under a guarantee in regard to items of cost in manufacturing and quality of gas. During the early summer the apparatus was set up in the works, taking the place of two old benches, which were pulled down and the bricks used for the generator pit, which is eight feet deep, and is floored with plank on railroad iron at the level of the retort house floor.

Doubtless most of those present are acquainted with the Springer design, but I have brought a blue print or two which may perhaps make the operation clearer.

To get at the root of the matter, consider if you please a vertical section of the cupola. We have, say, 600 pounds of coal in the generator, supported by the double extra wrought iron pipe grate, through which water flows to the seal. Below this grate the blast from a No. IV. Sturtevant blower enters and forces combustion upward. Just above the charging door, which is at the floor level, the brick lined generator is closed by a solid arch, so that the products of the first combustion—the so-called producer gas—can escape to the superheater only through the outside brick-lined cast iron tees, which give opportunity for the cast iron valves and seat away from direct influence from the fire. This valve being open, the producer gas enters the bottom of the superheater and passes up through checkered brick work in the usual fashion and out through flat valve at the top of cupola into wrought iron stack, and so through the roof. At the bottom and half-way up the superheater suitable nozzles admit blasts from the blower to complete combustion, regulated by conveniently placed lever gates.

Thus far we have practically the ordinary cupola; now for the special points. Our guarantee calls for a 20-candle power gas with use of 5½ gallons of Lima oil per 1,000 cubic feet. In order to practically use the crude oil the present style of cupola was designed—this one of our's being, so far as I know, the only Springer in New England. The differences are as follows:

Steam of 80 to 100 pounds is admitted *on top* of coal in generator instead of below it, so that the fuel gas is made by a downward passage through the incandescent coal. From the ashpit a fuel gas pipe passes outside the cupola to the top of the superheater, being furnished with a suitable brass expansion joint and a lever gate at convenient height. Through this pipe the fuel gas (CO and H) passes to the top of superheater brick, where it meets the spray of oil thrown in by a steam injector, to which the oil runs by gravity from an elevated measuring tank. Thence the fuel gas, now enriched, passes downward through the checkered brickwork, reaching gradually, and last, the hottest

brick, thereby giving better opportunity for the greater part of the oil to be made into gas with less amount of tar and lampblack. From the bottom of the superheater the gas passes to the wrought iron seal, and thence to usual condensers and purifiers.

The disadvantages of this apparatus are evident—namely, a certain complication of parts, as some nine gates and valves must be handled twice during each 20-minute run, besides engine connections. The advantages are of course equally apparent in the practical use of a cheap enricher and a low figure for coal per 1,000 cubic feet made.

Our figures, based on a make of 40,000 cubic feet per day of 12 hours, may be interesting, and are as follows: Labor of one man (gas maker), who does all work in connection with cupola, except bringing in coal, which is done by night watchman, who also looks after purifiers, etc., etc. On this basis of 40,000 cubic feet per day, our coal should not exceed 38 lbs. per 1,000 cubic feet, and oil, as above given, not over 5½ galls. As oil in tank cars at the works, losses reckoned, costs us less than 3 cents per gallon, we are able to put gas into holder at a very reasonable figure.

The question you will naturally ask is, "Are we satisfied with cupola and crude oil?" I will answer, "Not entirely;" and the objections are, perhaps, these:

1st. The powerful odor of the unburned gas, which renders very small leaks extremely offensive to consumers. This odor is, of course, beneficial on the score of discovering leaks; but is, on the whole, a disadvantage.

2d. The liability of the cupola, if not in first-class condition, to make a troublesome light tar which passes condensers and purifiers and makes serious bother at the burners, and gives an odor to the burning gas which is noticeable in closed rooms. This can, of course, be avoided by proper care in gas making; but we all know that the undesirable will at times appear. In this connection the very expressive phrase of one of our (of course) *clothiers* is to the point: "Mein Gott!" says Vesehoff, "dot gas haff a —— fine light, but it haff a —— bad schmell!" And this reminds me—if you will pardon the break—of another of Vesehoff's remarks, which is a fact properly vouched for. He appeared one day at the counting room of the Manufacturing Company, and inquired for a certain Courbet, a Frenchman. "Doesh he vork here?" The paymaster assented. "Vell," said Vesehoff, following the natural instinct of his race, "doesh he bay his bills?" "Well, no," said the paymaster, "I doubt if Courbet does pay his bills." "But, mein freund," retorted Vesehoff, "he *must* bay his bills! Vy, I haff solt him a sute of glose!" "I'm afraid, Vesehoff," replied the paymaster, "that you're caught this time; I doubt if you get a cent out of Courbet." "Ach, mein Gott, mein Gott!" lamented Vesehoff, "I vish I hat known dot, and I vould not haff charge him so much for de glose; and den I vould not lose so much!"

But to come back to business. As another point, we cannot, as we desired to do for the benefit of the mills, run a high candle gas, as our experience has been that a gas above 24 candles will smoke and smell when burning; although we can make such a gas and still not exceed our guarantee of 5½ gallons of oil, yet we find it advisable not to run over 20 to 22 candle power, with corresponding decrease of oil.

We cannot properly charge the new apparatus with the bother—very serious while it lasted—from the cutting out of accumulations of old tar, naphthaline, or what not, from the mains by the new gas, the stopping of tips thereby, nor with the equally serious trouble which we had with our condensers and purifying material, until the experience came which enabled us to handle these properly for the new gas.

But under our special circumstances there is one other point of importance. I had with coal gas introduced and sold at reasonable rates a large number of the albo-carbon cluster burners, and was thereby enabled to displace kerosene to a considerable extent, with great satisfaction in the light to consumers. The trouble now is that the new gas does not work as well with these burners as the coal gas did, tending to form a black deposit of carbon in the heaters, and so affecting the Bray special tips that it was necessary to cut out the cloth checks entirely. This remedies the stopping, but interferes somewhat with the steadiness and quietness of flame, which was a great advantage with the old gas.

Speaking of steadiness of flame, I may perhaps mention a point given to me some little time since which was new to me, although it may be an old story to you here. I have found it of benefit, however, and perhaps some one else may appreciate it. It is this: If the tip of a burner be so adjusted that the minor bottom curve of the enclosing globe is on a horizontal line with it—ordinary 4 or 5-inch globe holders being used—the flame will be perfectly steady, giving an entirely satisfactory reading light, without the annoying flicker which any other position of the tip will produce. As for patent burners; we had trouble at first with Lungren's from a slight tar deposit in the regulator, which is now, however, overcome.

I have had also four Welsbach incandescent burners at work with the new gas for some few months, giving very satisfactory results as to consumption of gas and brilliancy of light; the weakness being, of course, in the durability of the mantles, as was expected. These four burners are, however, all running at the present time—sold to consumers—and so far, including the four mantles now on them, I have used eight months, two of which were broken by the breaking of the chimneys and one by curious handling by a careless investigator.

As a conclusion, in regard to the comparative availability of the gases, we have now a gas giving a markedly brighter flame than the old, but with characteristics which about neutralize this advantage. We are able to manufacture more cheaply than before, but perhaps not markedly less than modern methods of coal gas manufacture would have permitted us to do, especially as our market for residuals has always been good.

But in addition we have the advantage—and, as I have said, the important point with us—of an apparatus of ample capacity to handle our wide range of output, due to the concentration of so large a portion of our business in the mills, which may burn all day one day and use scarcely a thousand feet the next. As for the dangerous quality of the new gas we find a certain difference in degree. A heavy dose of the new gas will give a severe headache, where similar inhalation of coal gas would scarcely have been noticed. We are, perhaps, less inclined to tap with pressure on in narrow trenches, although I made a first experiment myself in a bad trench without ill effects.

I have had no opportunity to study the chemical composition of the gas, nor have I its specific gravity. Its increased weight requires a tip about two sizes larger to get proper sized flame. A seven-foot burner I give the preference to. The candle power I arrive at by tests with a bar photometer, which I constructed some little time since, compared with the Jones jets, which are our common reliance; as a proper bar test takes more time than I can often give.

We young men in the small works who get a taste of everything from stock-ledgers to Stillson wrenches, have perhaps too little time for any one thing by itself. The varied experiences are, however, good for us, and if, after we have frankly stated some of our difficulties before this goodly Association, the older and wiser heads will stand up too and say the words which will give us a lift over an obstacle, we shall feel that the time spent over our efforts has been, for ourselves at least, not wasted.

Discussion.

Mr. Lansden—In figuring the coal at 38 pounds to 1,000 cubic feet of gas, do you figure the coal required to make the steam for running the apparatus; or is it just the number of pounds of hard coal used in the generator?

Mr. Chase—It is the number of pounds used in the generator. We used in addition to that about 10 pounds in boiler.

Mr. Parker—Your average for the year would be larger than that?

Mr. Chase—Yes. That is on the basis of making an average of 40,000 cu. ft. We do not make that average.

Mr. Sherman—I move that the thanks of the Association be tendered to Mr. Chase for his exceedingly fair and impartial report of his experience in the manufacture of water gas. It is the best paper I have ever heard read on that subject. (Applause.)

The motion prevailed.

[To be continued.]

Notes and Comments.

By OBSERVER.

We now pass out on to the street. Larger mains and services are being put down than formerly. In fact, owing to the increased and ever-increasing demand for gas, this is necessary, and large mains insure to gas men that great desideratum—a low-working pressure, which, of course, means a minimum of leakage and a more satisfactory supply to the burner than where small mains are in use and a high pressure has to be maintained to insure an adequate supply.

If two leads are run from the gas works in opposite or parallel directions (according to conditions), but meet and connect in the center of the town, I think the plan a very desirable one; for a more *uniform* pressure is thus obtained than where only one main supply exists.

In running services care should be taken to close up thoroughly the openings made in the wall through which the pipes pass. It is at this spot that frost proves troublesome; for if an aperture or chink is left a

current of cold air passes around the pipe. A curb-cock is a good thing to have, in case of fire.

The meter is a very important factor in the supply of gas. Much is expected—too much, probably—from this much abused, yet faithful and uncomplaining servant. If the gas is poor or the supply inadequate, it is the meter; if the lights are unsteady, it must be the meter; and if the bill is large, it is undoubtedly the meter that is at fault. It is usually set in some place so as to be "out of the way"—any place from the coal hole to the cupola. There are some places where a meter should not be set—a very warm place, a damp one, under the sink or washbowl, or near the butcher's salt barrel. A meter should never be allowed to hang, but should be placed on a firm, level shelf.

I think the capacity of a meter is often over-estimated. I have known gasfitters (?) to recommend a three-light meter to supply 15 or 20 burners; and they would declare with the fullest assurance that a meter of that size would carry 12 to 15 lights. It may "carry" them; but it is expected of a meter that it perform something more than offer no serious resistance to the flow of gas to the burner. A *meter is a measurer*—please to emphasize that;—but it is apt to fail of its whole duty when overworked—and have its days shortened also. I believe the question of meter capacity was discussed recently in one of our Association conventions, where the rates settled on were, say:

30 feet per hour for a 3-light meter.
50 " " " " 5 "
100 " " " " 10 "

And so on.

Shall we take out the meter? This is a question the gas superintendents are asking themselves, where the electric light is mainly used, but where they have gas to fall back upon when the former illuminating vehicle fails, as it is apt to. I would answer, "No." This is "the last link" that connects the gas company with the consumer. That severed and we are out on the street. I admit there are two sides to this question—and it is exasperating sometimes to have our light called on "to play second fiddle" to its inferior; but as the lane is long that has no turn in it, and in view of the great future that gas has before it, it is best to do all possible to conserve its every interest at present.

Where the arc light has displaced the gas lamps on the street, the riser should be capped up and the lanterns removed; but do not remove the posts. They will not bring more than old iron is worth, and they are worth more to the city to stay where they are. A small town out on the Illinois river was recently saved $500 in one year by this proceeding. They (the lamp posts) kept the local electric light company "in good form."

If the streets are lighted by gas permit me to suggest keeping the lamps clean. I have seen lamps where the glass was so dirty that the light was very seriously obstructed. On the other hand, an example of the most effective street lighting by gas that I had ever seen was at Minneapolis, Minn.; and that, in great measure at least, was because of clean glasses in the lantern frames—though it may be well to add that good gas and five lamps to the block (of the boulevard proper) may have had something to do with it.

There seems to be a growing tendency among gas companies to keep burners in order, to supply new ones without charge, etc. This is as it should be. The electric light men *have* to keep their carbons, wires and what-not in order. I say they *have* to do it, for if they did not do so their "occupation would soon be gone." Mr. James Cheney, President of the Fort Wayne (Ind.) Gas Company, says it is the manifest duty of the gas companies to take care of the burners. Now, Mr. C. is a gentleman of much experience, has given the gas business close study and attention for many years, and knows what he is talking about. He claims that the same burners that were put on when the gas fixtures were originally placed are often allowed to remain on for years, to corrode and clog and afford an inferior light, with the result that the blame is charged to the gas; and hence that it is the duty of the gas company to see to it that its light is being used under the best possible conditions, just as much as it is the business of the electric light company to make the best of its light. I call that good square talk, and would like to say further that we might do well to copy the form of the electric light burner—I speak now of the incandescent electric light; for (first) it points downward and throws its light in the same direction; second, its light is inclosed in clear glass. But we, with gas, light our ceilings mainly, and afterwards our tables with what is left from the further toll taken by a heavily ground globe, perhaps surrounded also by a highly-colored shade. It may be stating it rather broadly, but I believe we do not get to our tables more than 33 per cent. of the illumination that the gas affords. It strikes me that there is a fortune right here for the one who will give us a good and cheap burner after the pattern of the incandescent electric light.

I think the gas business should be conducted like any other business. The seller is the servant of the buyer; yet I have seen this order reversed—not often, but often enough. The average gas consumer is a peculiar being. Rational on all other subjects, when he talks of the gas business he is often the reverse of it. The gas is bad, it smokes up the ceilings (an evidence of a latent high candle power usually, but he does not know it), the supply is poor, and he *knows* something must be wrong with the bill. He has been using electric light and still he has a large gas bill; and we all have met the consumer who has received a bill for gas consumed during a period when his house was locked up and no gas was used in it at all! It is not an easy thing to satisfy this man. He comes into the office to pay a bill under protest, and his feelings are likely to resemble those that must have permeated the man who we are told went from Jerusalem to Jericho only to fall among thieves. Now, it takes someone with a patient, well-disciplined mind (a Carpenter, in fact) to send this man away smiling, with that bill, receipted, in his pocket. No doubt about it; yet I have seen it accomplished.

When such complaints are uttered I think we should do all we can to satisfy the aggrieved party. It is possible for his meter to be wrong, or that the statement was imperfectly taken, or possibly some "gas expert" has sold him a patent burner, guaranteed to furnish a better light for less money; indeed the house might have been locked up in reality and the statement taker, presuming the occupants had just gone out for an hour, "averaged" the consumption from the previous month, whereas the family had been absent for a month. I remember a case where the statement taker had given the gas company much trouble and annoyance because he used "his judgment;" or rather he did not. A man taking statements should be like a machine, recording exactly what the meter says, irrespective of an increase or decrease in consumption, or no consumption at all.

[To be continued.]

An Ancient Reservoir.

The works which the Gas and Water Company of Tunis are now completing are of exceptional interest from an historical point of view, being nothing less than restoration of the old covered reservoirs of Carthage, which date back fully two thousand years. From the description given in *La Genie Civil* it appears that these reservoirs form a block measuring 420 ft. long by 89 ft. 6 in. broad. The interior of this block is divided into eighteen compartments, all of which are in communication with each other and with the incoming and outgoing conduits. During their long existence these cisterns have passed through four periods, alternately of repair and neglect, evidences of which are furnished not only by the different varieties of masonry occuring where repairs have been effected, but also by the character of the various layers of deposits on the walls of the tanks. The first layer of this deposit probably dates back to the time of Hannibal, when the cisterns were in full working order. It is very uniform, and apparently corresponds to a considerable lapse of time; that portion which was first deposited is yellowish, becoming whiter as time went on, and more care was taken with regard to the quality of water impounded. After the Roman conquest the tanks fell into disuse, and the water in them rapidly became foul, an irregular dark-colored layer being deposited on the sides. The Emperor Adrian repaired the tanks and impounded in them the waters of the Qaghaouan, and during this period a third layer, pure and white as the first, was deposited. But this state of affairs was put an end to by the irruption of the Arabs in 697, and since that time the cisterns have been entirely neglected, and during this period the fourth layer was deposited, which is familiar in all respects to the second. The French company have practically revived the scheme of the imperial engineer, and under their auspices the reservoirs will enter on a new career of usefulness. In cutting through the retaining walls of the cisterns it was found that these walls were thicker near the ground level than lower down, the reason for this arrangement probably being that the ground was excavated without walling boards or any other arrangement for keeping the sides of the excavation vertical, and the space between the earth slope and the true vertical line was filled in solid with masonry instead of soil.

THE Thomson-Houston type of plant recently ordered by the Natchez (Miss.) Gas Company was turned over to the latter on the 3d inst. The streets are now lighted by arc lamps, and Natchez is pleased. The contract with the Gas Company is to last for 5 years.

Municipal Lighting.

By Mr. Fred. H. Whipple.

[Read by the author at the Chicago convention of the National Electric Light Association.]

There are so many difficulties encountered in a proper consideration of the title of this paper that one does not embrace the suggestion to discourse upon it with enthusiasm. It is a subject seemingly rebellious to analysis, yet one that requires to be treated in language whose clearness is inexorable. In these times one writes and speaks to the multitude, and upon questions broad in their scope and far-reaching in their effects one ought never to shut himself up in any sort of freemasonry of his own building. When an issue such as this presents itself to the electric light world for discussion, it should be treated fairly and squarely, with intelligence and judgment, and without the heated arguments of business controversies.

"Municipal Lighting," as generally considered, means the municipal ownership of the plant. I think this definition is erroneous, for the reason that the greater portion of the income of two-thirds of the electric light companies of the country is derived from their public street lighting contracts. Of the total number of arc lights manufactured by private companies who are parties to a city contract 68 per cent. are public lights, and are paid for by the municipalities. On the other hand, of the total number of arc lights upon the streets of the land, but one-third of 1 per cent. are owned and operated by municipalities. Therefore the logic of the subject is not confined entirely to the question of ownership. The issue, to my mind, is based as much upon the rental value of an arc lamp.

What is the rental value of an arc lamp? Statistics regarding the price paid by various cities are not lacking, but comparisons are worse than useless; for they seemingly go upon the principle that a light is a light, no matter what it lights, what it costs to produce it, whether it has good illuminating capacity, or whether the system be an inferior or superior one. The prices for light vary materially in different places, but I have been unable to see that they vary in accordance with any fixed relation to any other factors which would seem to have a bearing on the service. It may be truly said that nothing has an absolute value. It would be impossible to prove, on a general hypothesis, that 50 cents, or any other sum, is in any place the exact value of an arc light; but in this, as in all other cases, some price must be fixed.

In the staple articles of the world's production the law of supply and demand regulates prices; but as electric light companies, in their relations to city councils, act under influences individual in themselves, the case is very different. The price of light for commercial purposes is to some extent regulated by the fact that moderate prices materially increase the consumption; but in municipal lighting, the city, if it accepts the terms offered, generally pays the contracted price. It is, therefore, in many, if not in most cases, a matter of comparative shrewdness of the officials on either side as to the price paid, and the service rendered.

There are to-day in the United States 316 cities and towns whose streets are wholly or in part illuminated by electric lights furnished under a public contract. The highest price paid for an arc light of nominal 2,000-candle power, burning all night, is $360. The lowest is $40. Between these two extremes there are 186 prices. Upon the moonlight schedule the maximum figure is $165; the minimum, $50.

What makes these wide differences in price? Granted that in many places local conditions, excessive competition, or the absence of all competition have weight in determining the cost of production, what reason shall we give for the varying figures exhibited in a wide field of localities where the conditions are almost absolutely identical?

The average cost of all-night public lighting in the United States to-day is $121 per light; for schedule lighting, $110. In 1885 the cost was, on an average, $167 per light for all-night lighting, and $135 for schedule lighting. In 1886 it was $160 and $125. In 1887 it was $130 and $117. In 1888 it was $129 and $114. Thus we find that the price of public lighting has been steadily decreasing for several years, and to a very large extent within the past few months. Contracts that have been renewed since the last meeting of this Association in September show a net reduction upon all-night lighting of 23 per cent., and upon schedule lighting of 19 per cent. The general run has been from 15 to 33 per cent., but there are several cases reported where the reduction has exceeded 50 per cent. An increased contract price is rare—less than a dozen so reporting; and the highest figure reached is 20 per cent., while the lowest is 8 per cent.

These statistics do not furnish any guide as to the rental value of an arc lamp. The price paid by one city is often twice as much as that paid in a neighboring city, yet one would scarcely wish to be quoted as saying that the cost of production was in the same relative proportion. It is obviously worth more to produce a light in one place than in another, but is it worth twice as much? It will no doubt be said that different degrees of illuminating candle power enter into the problem; but in my computations I have considered none but nominal 2,000-candle power lights. Sometimes the area lighted is pushed forward in explanation; but this has no connection that I can see with the cost of the light itself.

There is really no fixed basis upon which to charge for public lighting, nor any general data by which a fair rate may be arrived at. I am, therefore, of the opinion that coincident with the discussion of ownership should come that relating to the value of the light, for this is really the primal cause for so much agitation of municipal control.

When it comes to the question of ownership, there are three parties in interest—the parent companies who manufacture the material to be used, the local companies that have invested their capital in a business they have the natural right to make as lucrative as possible, and the public, represented in an intermediate capacity by municipal councils. Accordingly we find three separate and distinct views taken of the question, and we are forced to believe that all three are right from their standpoint.

Of the three factors the local companies are the only ones presenting a solid front. They are united in the expression that municipalities ought not to do their own lighting. In view of the constant decrease in the price of electric lighting previously shown, and the transitory periods of electrical machinery, the local companies are mechanically correct in their claim to be able to generate electricity as cheaply as a municipality. Many of the circumstances, by reason of which the sentiment favorable to municipal ownership became prominent, do not have force to-day. The new and improved formulæ and the cheapening processes of production private companies are able to take advantage of where municipalities would not. Compound and condensing engines have made it possible to reduce the cost of power; more light is produced from a less expenditure of energy; carbons have fallen from $50 and $60 to $8 and $10; it is no longer necessary to locate a station in the central, and therefore the most expensive, portion of a city, and more attention is being paid to water power. All these are contributory to the claim of the private companies that municipalities should not enter into an investment, the extent of which they are ignorant of, in the face of a declining market.

With the parent companies the effects of municipal ownership are just beginning to be appreciated. There is no doubt that these organizations will at no distant day be brought squarely to face the alternative of refusing to sell material to municipalities altogether, or of going out of business. It has been their custom, while acknowledging an unwritten obligation to protect their local companies, to consider that they are not bound by any special dispensation to refuse a sale when the opportunity presented itself. They are not prepared to say that it is inadvisable for a city to operate its own plant so long as the city already has the other fellow's system installed. When it comes to a city which has a private plant of this or that particular system, then this or that particular parent company is decidedly opposed to the city embarking in the business.

For these truly natural characteristics capital is quickly bringing the parent companies to a halt. No company is large enough or financially strong enough to organize and operate the local companies necessary for the times. Therefore it is local capital and local activity that are the mainstay of the parent companies. Capital is always nervous, and we can readily see that with the continued growth of a sentiment favorable to cities doing their own lighting, capital will not run any risks. It will not invest in a city or town where a community interest stares it in the face.

There is another reason why the municipal ownership of plants does not run parallel with the interest of manufacturing companies. In the case of the municipality the net result of a year's operation is public property, while it is to the interest of private corporations to keep within their own knowledge the actual outlays. A larger increase in the amount of goods required may also be expected from them than from municipalities. And from the exasperating incidents of carrying through a municipal deal, with its attendant train of demoralizing influences, every company would fain be freed. I do not believe there is a parent company in the country that has made money by selling plants to municipalities. I know some who have lost money, and I wonder that as a whole they are not ready to commit themselves unqualifiedly and negatively upon the subject of municipal ownership. The time is near when they will be forced to go upon record in this matter, but to-day they are vacillating and uncertain. They believe that in some cases it would

be a manifest advantage for cities to own their plant, and in other cases just as manifest a disadvantage. They would like to have each case stand independently.

In considering this subject from the standpoint of the public servant, it becomes at once a question of advisability, to which is naturally attached, although seldom considered, the element of responsibility. The theory of the political economist is that the monopolies of service should be owned by the municipality, and all belong to the community. In European countries this idea is carried to a much further extent than in our own. In many English-speaking communities the public service does not stop with light, water, and transit, but municipal ownership often extends to the bath, the laundry, and the bakery.

It has been more gradual in America, doubtless because the tendency of the times in all municipal governments is toward political aggrandizement, and that it inevitably leads to corruption and a debauchery of the public service. It has therefore become necessary to largely restrict the functions of the local government by more general legislative bodies. In America politics is the national characteristic, and the ordinary politician is only theoretically honest. He recognizes moral turpitude only to the extent of dreading exposure of his own backslidings, and while, if he break the law, he nevertheless outwardly insists on the sancity of the law. Municipal service can be, and ought to be, administered with quite as much freedom from assumption as when in the hands of private parties. But in few instances do we find it so administered. We are thus confronted with a condition, not a theory; and in the municipal ownership of electric light plants this condition is easy of demonstration. I believe I can truthfully say that the experience of city governments in this line has not been in all respects satisfactory. Starting out a year ago as the investigator for a large municipality, I have closely studied the workings of almost every city plant, and, with one or two exceptions, I would not now commend their operation. The officials of the smaller towns where municipal plants have been installed, with an amount of crude ignorance of the subject that is truly appalling, do not hesitate to assert that they and the people are well satisfied with the experiment; but, in the majority of cases, these officials are in office largely through the machinations of rings, and it would not be in the line of policy for them to decry the schemes of their associates.

The illumination of towns by themselves is on the intermittent plan of lighting, the hours varying so that no basis for comparison can be arrived at. The average advocate misinforms the investigator by holding up to view the proposition that these cities are doing their lighting for a merely nominal cost, while his figures are really superficial and not entitled to support. They are figured on isolated conditions to suit the emergency, often with items charged to other departments for the sake of a plausible showing in the lighting account. On one occasion, where I was called upon to estimate the cost of an all-night service for a large city, upon its merits, my figures were $92 per year, with interest and depreciation; and that, I think, is not very far from the cost of an arc lamp in our average communities. A strong claim is made that, notwithstanding the prejudicial influence of politics that enters into their management, municipal stations have reduced the cost of public lighting in their localities over the contract system.

I have previously stated that the average present price of public lighting in the United States is $121 per arc lamp per year, burning all night, and $110 per lamp burning on schedule. The average cost to municipalities, which are furnishing their own light, is $76 for an all-night light and $44 for what they term a schedule light. This schedule is deceptive, and does not provide for as many hours' lighting as the usual contract does. Therefore the latter suffers by comparison. It is often the case, also, that the light is furnished in connection with some other department which bears a portion of the interest and depreciation account. Free water power and sometimes so-called free attendance also enter into these figures and distort them.

The only argument worthy of consideration in favor of municipalities doing their own lighting is that of cheapness, and emphasizes what I have said in a previous part of this paper, that an important question involved is the rental value of an arc lamp. Municipalities have not yet succeeded in reducing the price of light abnormally below the average. I do not consider the fact of any weight that a city, by reason of its not being compelled to pay taxes, and because it has no profit to make, can manufacture light cheaper than a private company, for I expect that what it saves in this way will be counterbalanced by losses caused by the influences of its management.

Here arises the question of a personal financial responsibility. We have become accustomed to consider that all public business, being in a sense everybody's, is really nobody's, and too often it is the case that a mere perfunctory public duty is performed for the sole sake of the salary attached to the office. Any business enterprise to be conducted successfully, ought to be carried on by men who are financially interested in it, and who feel in their own pockets the cost of every expenditure. A city government cannot possibly take that view of it, even though its departments were paved with good intentions.

There is but one view, and that a conditional one, in which municipal ownership can be indorsed. If the expense of the plant can be kept within reasonable bounds; if the management is in all respects such as you would commit your own private business to; if there are no outside prejudicial influences, then from the standpoint of the public servant it would be desirable for some cities to do their own lighting. Without these qualifications it would be inadvisable.

The price of public lighting has outstripped all other questions in the financial management of our cities. It has become, if not the chief source of expense, the greatest bone of contention; and the electric light companies that will observe the handwriting on the wall and meet the subject half way will do much to dissipate this sentiment antagonistic to its interests.

There is room for improvement in public lighting. Contracts are not made by people living in a millenium, but by the mingled good and bad as they are found in the business world and municipal councils, and as they probably will be found for some time to come. These are several sides to this, as to all questions, and there is a happy medium. In this medium the electric light fraternity should clasp hands with the well-meaning and observant public servant, and see to it that, while fair profits are returned for the service rendered, a union of interests is formed, cordial in its nature, though commercial in its results; and there will then be no occasion for public sentiment manifesting itself in the municipal ownership of electric light plants.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

Mr. Thomas C. Cornell, President Yonkers (N. Y.) Gas Light Company, notifies contractors that the Company wants proposals for about 50,000 yards of filling to complete the grading at the rear of its new bulkheads. It is stipulated that the material used must be satisfactory to the local board of health, and that the covering must consist of earth or steam furnace ashes.

As noted before, the Winchester (Va.) Gas Company is installing an electric light plant, having been moved thereto chiefly because of the desire of the authorities for arc street lighting. The contract with the municipality calls for the maintenance of 40 arcs (in passing it might be mentioned that each is to have an illuminating value of 1,500 candles, which is bringing the lighting capacity down to a narrow range, since we already have them rated at 2,000, 1,800, 1,666, 1,333, or 1,200 candles), to burn until midnight, and to be paid for at the rate of $70 each per annum.

Messrs. R. D. Wood & Co., Phila., have been awarded the contract for the ironwork on the Louisville (Ky.) Gas Company's new relief holder.

Having waited in patience but in vain for some tangible evidence by the city of Omaha that it would pay the Omaha Gas Manufacturing Company the sum owed the latter for maintaining the public lighting of the city during the term embraced between Aug. 1, 1884, and Jan. 1, 1888, the contractors have at last brought suit for a settlement. The Company asserts in its complaint that it entered into a contract with the city in September, 1883, under which it was to furnish gas to the street lamps and the public buildings; that it has been remunerated for the quantities supplied from Sept. 1, 1883, to Aug. 1, 1884, but that the quantities taken up between the last-named date and Jan. 1, 1888, have not been paid for, although the contractors did not at any time deviate from the regulations and spirit of the agreement. Complainant also alleges that the city is now paying for a similar service at the original contract rates. The authorities reply that the original contract with the Omaha Gas Manufacturing Campany was assigned by the latter to the United Gas Improvement Company, without the city's consent; hence the city is not liable under the September, 1883, agreement. Also, that the Company had not lived up to its contract in several important particulars. The defence is rather weak, and it is likely, in fact certain, that the city will have to pay up. As the sum involved is not far from $50,000, the Company's treasury will be a good gainer by the receipt thereof.

Mr. I. C. Baxter, who has for some time been in charge of the plant of the Detroit (Mich.) Gas Company, is to be congratulated on having

secured the services af Mr. T. W. Summers (late of Chattanooga, Tenn.) as Assistant. In the meantime Baxter's former stamping ground—Evansville, Ind.—seems to be getting along. Perhaps the Hall regime is responsible for some of this success.

WRITING under date of Feb. 28, Mr. James Somerville, of Indianapolis, Ind., says: "After reading Mr. Dempster's interesting paper on American gas making in the last issue [Feb. 25] of the JOURNAL, I could not help feeling some regret that he did not visit these works. I am sure had he done me that honor he would have seen some things he said he did not see. 1st. He would have seen a retort house free from smoke or flame, except when the benches were being drawn and charged. 2d. He would have seen the hydraulic main raised about 2 feet above the brickwork. 3d. He would have seen a tower scrubber at work which practically takes out all the ammonia, and the liquor, so far from being considered a nuisance, is considered a valuable product. 4th. He would have seen a sulphate plant at work turning out as white a sulphate as ever he saw in England, and selling at a very satisfactory price. And 5th and last, he would have seen a square station meter. Yours, JAS. SOMERVILLE."

THE Rich Hill (Mo.) Gas Works will absorb something like $35,000 for buildings and manufacturing plant. It is expected to have everything in order for supplying gas on or before August 1st.

WE are indebted to Mr. H. F. Coggshall for the following, dated March 1st: "Messrs. Rodney Wallace, T. K. Ware, Chas. T. Crocker, H. F. Coggshall, Herbert I. Wallace, and Francis B. Shepley, having purchased 8,278 shares of the 10,000 shares issued by the Wachusett Electric Light Company, a meeting of the Directors of said Company was held, at which Walter A. Fairbanks, President and Director, O. H. Lawrence, G. E. Clifford, and Jas. L. Chapman, Directors, and Geo. E. Clifford, Treasurer and Assistant Clerk of said Company, tendered their resignations, and Rodney Wallace, T. K. Ware, Chas. T. Crocker, Herbert I. Wallace and F. B. Shepley, were chosen Directors; T. K. Ware was elected President, and H. F. Coggshall Treasurer, Asst. Clerk and Manager of said Company. It is contemplated to erect a new station, and to increase the plant to meet the demand for this beautiful light; and we trust that the day is not far distant, with the improvements constantly being made in electric lighting apparatus, that this light can be sold as cheaply as gas; and with the constantly increasing demand for gas for light and heat the two will go hand in hand together." The above is the notice that was printed in the Fitchburg daily papers respecting the change in the vested ownership of the local electric lighting enterprise. Of course it all means that the gas company is now in control. And it may be taken for granted that Mr. Coggshall, who always was a busy man, will be kept on the run to manage the various interests with which he is identified—gas, electricity, and heating by meaus of hot water circulation. He will succeed with them all, however.

THE Cabot trays, for either lime or oxide material, still retain prominence, no less than 97 sets having been sold in 1888, which were ordered by 85 different gas companies; and distant Venezuela is represented on the list. The "Church Oval" is the specimen that commands the greatest favor, if the largest number of orders received for any one style is to be taken as the standard. Still, since the "Church Reversible," with grooved slats and malleable iron cross bars was first placed on the market—not much over a year ago—these have been taken by 35 different gas companies, in 38 sets.

THE new East End plant of the Cleveland (O.) Gas Company is to be placed on a portion of the plot (8 acres) owned by the Company at a point on the lake shore, the other boundaries being the Pittsburg switch and the rails of the Lake Shore Railroad Company. Permits for the retort and holder houses have been issued, and these are to be located at the foot of Willson avenue. In the meantime, we might remark that the Faulhaber opposition ordinance yet remains "hung up" in the City Council chamber. There is but little fear that it will not be removed before it is thoroughly dried.

THE Faculty at Dartmouth College is said to be engaged in the making of estimates as to the practicability and economy of lighting the College buildings by electricity through the medium of an isolated plant. Some observers say that if such a step were taken it would mean the closing down of the works of the Hanover (N. H.) Gas Company, which is supported mainly by the demands of Dartmouth College. It is no wonder that the College officials are dissatisfied with the service rendered by the Gas Company, a "pure oil gas" being the sort of illuminating agent distributed. The proprietors of the Company, however, ought not to complain; for at no time did they omit to pierce the bread that they cast upon the waters with a well-barbed hook, not to say anything about the line to which the hook was attached!

THE stockholders of the Malden and Melrose (Mass.) Gas Company have voted to increase the capital stock from $170,000 to $220,000.

THERE is every reason for saying that the Framingham (Mass.) Gas, Fuel and Power Company will erect a plant on the Loomis system at Framingham this spring. The Company is to be capitalized in $75,000.

ACCORDING to the report of W. H. Hinkle, Engineer of the Little Rock (Ark.) City Electric Light Station, the cost of running the same (we believe it is said to have a capacity of 100 arcs, 2,000-candle power) for the three months ending March 1, 1889, is as appended—the charges are divided or assigned against the generating or "power" division, and the distributing or maintenance division. It will be noted that the report is silent on many things that ought properly to be charged against the station; although Mr. Hinkle should not be accused of trying to hide anything, since he says that his report is "merely a statement of the actual expenses of the station." The figures are:

370,825 pounds nut and slack coal	$361.00
30 gallons engine oil, at 50 cents	15.00
34 " cylinder oil, at 60 cents	20.00
25 pounds cotton waste, at 10 cents	2.50
10 " piston packing, at 40 cents	4.00
1½ lbs. sheet gum, at 35 cents	.50
5 pounds belt grease, at 30	1.50
Repairing fire irons	3.00
Wages, engineer (per month, $75)	225.00
" fireman (per month, $50)	150.00
Total (power department)	$782.50
Wages, electrician ($100 per month)	$300.00
" lineman ($40 per month)	120.00
18,000 carbons (per M., $12)	216.00
35 gallons oil, at 55 cents	19.25
50 pounds cotton waste, at 10 cents	5.00
5 pounds belt grease, at 30 cents	1.50
Broken globes	25.00
Feed for horse	26.00
Incidental repairs	15.00
Total (electric department)	$737.75
" (power department)	782.50
Grand total	$1,520.25

The table seems to be very incomplete. And one very significant feature is shown in the apparently insignificant charge for "incidental repairs"—allotted to the electric department alone—but which is in reality important, for it shows that that charge, on half the working, and in the very first quarter of the working, too, amounts even now to 1 per cent. of the total expense.

THE streets of Jackson (Miss.) were lighted by arcs for the first time on the 3d inst.

THE Harrison (N. J.) Council is in a quandary. Some time ago the authorities granted a contract to certain electric franchise speculators, who guaranteed that they would have 70 arc lights on the streets by the 1st inst. As said in these columns some weeks ago, the outlook for the redemption of their promise—within the time specified—was very slim; and so it has turned out. No penalty for non-compliance with the agreement was named, but in the meantime the contract with the East Newark Gas Company for public lighting expired on February 28, and the latter did not feel like keeping on with the work under the old terms until such time as the electricians were in readiness to take it up. While we do not positively know what decision was reached, we believe (between the interim of Council meetings) that the gas men will light the town on the old practice—moon-table, and extinguished at 1 A. M.—and expect eventually to secure a new contract by making concessions as to price and time of lighting, which will put the electricians in a worse plight that before the close of February, and that was bad enough.

CUMBERLAND, Md., or the authorities thereof, is experimenting with a system of brick paving, and it is said that it answers the purpose of ordinary travel quite satisfactorily. The bricks are formed out of clays rejected by the fire brick works at Williams (on the Pittsburg and Connellsville Railroad) as unsuitable for the ordinary fire brick product of the works mentioned. Although somewhat coarse in finish, they are at

once hard and tough. In placing for the road surface, the bricks are laid endwise, broken-jointed and in sand. A heavy roller is used for compacting, after which boiling tar is spread over them, that coating being immediately followed by a thin layer of sand. A smooth, solid road bed is the result, and noiselessness is one of its features. It should have been said that a carefully placed foundation of coarse sand, say 4 inches in depth, is first put down. A somewhat similar pavement has been in use for some time at Wheeling, West Va., where it is much favored.

San Antonio, Tex., as mentioned in these columns some months ago, enjoys the doubtful luxury of a wonderfully erratic sample of electric light supply, two rival companies being in the field. The source, although erratic, was cheap; for all that a customer had to do to secure a lower rate than the one paid by him in the previous month was merely to suggest to the campany, when paying his bill, that he was going to be served by its rival. So bitter did the fight eventually become that a month or two ago 2,000-candle (more or less) power arcs were supplied at the rate of 30 cents each for all night lighting—equivalent, say, to a charge of 15 cents for a similar service in New York city. Incandescent lamps (nominal 16-candle power—in reality, they did not average 10 candles) were furnished at prices relatively equal to those for the arc service. Still, the people who now drive bargains in the bustling place that once (when lazily nestling under the protection of the guns of Fort Alamo) cared naugnt for profit or loss, did not flatter themselves that 15 cent arc lights were to rule forever, not they, indeed—the Hebraic element in the lighting enterprises was far too strong to rest content without receiving some sort of profit on its wares. Nevertheless, while admitting that the low rate would give place to a higher one (although it was not agreed that the quality of the service would keep pace with the added price), we venture the suggestion that none were prepared for the schedule promulgated on the 1st inst. From it we learn that the rival companies have "pooled their issues," and issued a rate that averages 125 per cent. higher than the best of those prevalent "during the war."

The Watertown (Mass.) Gas Company will erect this spring a two-lift holder, 80 ft. 6 ins. diameter, height of lift to be 20 feet. This will add a plump 200,000 cubic feet storage capacity to the plant, and does not look as if the company's electrical annex were to be nursed at the expense of the original infant.

We understand that Mr. Olney is moving in the matter of raising the capital for the erection of a gas works at Huntington, L. I., the charter and franchise for the operation of the same having been obtained. This place is a post-village in a similarily named township of Sufflolk county, and is on the Long Island Railroad at a point about 35 miles east of Brooklyn. It is also on an inlet from Long Island Sound. A gas works ought to do well in this place, for were a fairly central location selected as a site the villages of Cold Spring and Northport could be counted on as feeders. Were this the case a population of 12,000 might catered to.

Mention of the Olney prospective enterprise at Huntington calls to mind a little dickering and rivalry now going on in connection with the lighting of the Prospect House at Bay Shore, L. I., in which latter place Messrs. Frost and Francklyn authorized Mr. Olney to construct and equip a gas plant, the same to be used in manufacturing gas under the Meeze patents. The works are now practically finished. The Prospect House, with its cosy and quaint reinforcement of cottages, is one of the principal hostelries in this very pleasant nook whereat to while away the summer days; but its owner and hitherto host, landlord Rogers, can hardly be classed as the most progressive of his brethren, for he never looked beyond kerosene lamps as illuminators of his grounds and chambers. Tiring of the glories and the vexations of a hotelkeeper's life, this season he induced Mr. D. Frankel, well-known as the senior member of the firm of Frankel & Lansing, of Brooklyn, to lease the Prospect. Frankel, of course, thought his guests would prefer to do their own disinfecting in their own way, and so decided to banish kerosas an illuminator. In determining on a substitute he was speedily brought to face with the promoters of the Bay Shore Electric Light Company and the Bay Shore Gas Light Company. The Prospect was not piped for gas, hence the electricians had a good start in the race for favor. The Gas Company, however, did not despair, and offered to allow the hotel man $150 towards fitting up, but this was no particular inducement, since the electricians would wire, fit and fix everything up without charge. In the matter of rates the gas company offered to furnish their illuminating agent for $2 per 1,000, whereas the electricians agreed to supply 20-candle power incandescent lamps at the rate of $1.10 each per month, arc lights to cost 50 cents each per night—the burning hours to be from sunset until 12.30 A. M. The electricians have secured the contract.

Messrs. Floyd & Sons, New York, have been awarded the contract for 12 benches of 6's, to replace 3's and 5's, at one of the branch stations of the Philadelphia Gas Works. These benches will be fired by means of the Flemming furnace, and will be charged and drawn by the Ross improved machines, Capt. Ross having just received an order for four additional sets of what is known in the Quaker City as "Wagner's Iron Man."

Mentioning this recalls to mind the fact that within a few days a specimen of the new Ross charging machine will be put at work at the 14th street station of the Consolidated Gas Company.

Mr. J. S. Lockwood has purchased the Kampmann interest in the San Antonio (Texas) Gas Company. This gives the former control of what undoubtedly can be made the best paying gas property in the Lone Star State.

Work on the gas plant at Cartersville, Ga., is in a well advanced stage. Main laying is going on at a rapid rate. The proprietors are confident that they will be in readiness to light the city by June 10th.

The petition of the Roxbury (Mass.) Gas Company for the right to operate an electric lighting plant in that district of Boston having been denied by the Board of Aldermen, the Company has taken an appeal to the Board of Gas Commissioners, who have named Saturday next as the day for the hearing.

Isaac Amberman, late Treasurer of the Jamaica (L. I.) Gas Light Company—to which position he was chosen in 1873—died on the 19th ult. He was held in high esteem by the residents of Queens county, where he had lived out (born at Springfield, Queens county, a village that adjoins Jamaica) the entirety of a peaceful and well-spent life. A striking feature of the demise of Mr. Amberman was its effect on his widow, who survived him but four days.

The City Council of Kingston (Canada) is considering the advisability of purchasing the local electric lighting plant and operating the same as a municipal attachment.

The Trustees of the School for the Blind (Little Rock, Ark.), caring evidently less for the safety of the afflicted under their charge than for the opportunity offered them to become amateur gas proprietors, determined to light the premises by means of a Van Keuren or Van Kenel Globe Gas Machine. The "plant" was planted in a building perhaps 16 yards away from the girls' dormitory. Some 10 feet away from the generator was located a tank capable of holding 400 gallons of gasoline! The machine was placed in position in 1885, and was under the charge of "engineer" Ringgold and "carpenter" Davis. All went fairly well until a year or so ago, when it was noticed that the gas was "becoming poor;" but poor or not, the Globe remained planted. On the last day of February, however, at about the time for putting the children to bed, a waving in the lights was noticed, and this eccentricity was instantly followed by a sharp explosion, a rattle of glass and a pall of darkness. It was speedily discovered that the "Globe" had not only turned on its axis, but that the building was rent in twain. Luckily the gasoline tank contained at the time only 80 gallons out of a possible 400; and even this remained intact. Had a contrary result been recorded there is every likelihood that the Blind School would have assumed the appearance of a combined morgue and hospital. It appears that the "mixer" of the apparatus was responsible for the leak which permitted the gasoline vapor to wander around until it finally made the acquaintance of the test light; and the rest is known. No one was seriously injured, and the damage is less than $700. Superintendent Dye coolly goes on record as having said, after the echoes of the explosion died away, that while he "did not consider it entirely safe, an explosion at this time was something entirely unlooked for."

Pottstown (Pa.) is squabbling over the price to be paid for lighting its streets by electricity, but the owners of the Gas Company are inviting bids from contractors to furnish them with a new single-lift holder.

The output of the Alpena (Mich.) Gas Company for the coming year will probably reach 4 millions cubic feet.

Control in the Fort Wayne Jenney Electric Light Company has passed into the hands of the Thomson-Houston Company. The new proprietors, however, are pretty keen to scent a good thing, and its

agent, Mr. C. A. Coffin, was instructed to say to the people of Fort Wayne (the Jenney shops at this point were destroyed by fire some three months ago) that if they would subscribe $30,000 in the shape of a cash bonus they might have the new building in their midst. We understand that the money has been raised, and that the Thomson-Houston people will at once erect a $40,000 structure there. We are of the opinion that that structure will not absorb more than the amount subscribed, and, further, that Fort Wayne must be a very philanthropic spot.

THE Birmingham (Kansas) Coal and Gas Company has amended its title to that of the Birmingham Land and Improvement Company, in order that it may buy, sell and bond real estate, etc. Its capital stock is fixed at $140,000, but we fear that as a gas company it will never make any great flare.

THE "New England Fireproof Gas Machine Company," of New Hampshire, has been incorporated at Manchester by Messrs. O. S. McDonald, H. N. Shepherd, W. P. Collins, P. Yarrington, W. H. Watts, L. G. Grossman and J. W. Talmage. It is capitalized in $150,000 (par $10), so that all may come in on the ground floor, and reap "a profit out of one of the grandest enterprises of the age." The thing is probably a bold swindle; for the Manchester *American's* young man speaks about it as follows: "The business of the Company will be the manufacture of gas generating machines for use in houses, hotels, stores, factories—in fact everywhere that gas is at present utilized. The concern will manufacture miniature gasometers and lease them, putting them in a man's premises at just half the rate he is at present paying for illumination. If, for instance, his gas bill is $100 a month, a machine powerful enough to illuminate his premises as they have been illuminated will be furnished for $50 per month. The machine is self-acting, containing as it does the elements necessary by the admission of water to generate a most brilliant *illuminating fluid*, and its contents will have to be replenished only about once in six weeks. It is averred that gas made from this method would give a blaze 18 inches tall from the ordinary 4-foot burner in use in dwelling houses. *Six-inch* burners are used instead, and the claim is made that gas can be produced for 5 cents per thousand." There, Messrs. Engineers, what do you say to this? A swindle and a farce combined? Perhaps that young man who measures the capacity of a gas burner in feet and inches might find congenial company out in Lincoln, Neb., where, according to ex-Inspector McGraw, the inhabitants think that candle power and horse power are synonymous.

AT a session of the Troy (N. Y.) Contracting Board, held Feb. 27th, the business under consideration was the lighting of the public lamps and buildings. The Troy Gas Light Company agreed to supply gas to the lamps at the rate of 90 cents per 1,000 cu. ft., that to public buildings at $1.50. The Troy Electric Light Company offered to maintain 271 arcs for the total sum of $44,511.75 per annum. The bids were rejected on the ground that the specifications called for a greater number of lighting hours than the Board intended.

AT a recent meeting of the Village Board of Hyde Park (a suburb of Chicago) Messrs. Hauk and McCleary asked for an ordinance granting them the right to supply the residents with gas for heating and illuminating purposes. They proposed to supply illuminating gas at $1.20 per thousand feet, less 20 cents for prompt payment, fuel gas to be charged for at 90 cents per M., less 20 cents. They guarantee to construct a works of ample capacity to meet any likely demand, and to file a bond in $20,000 as a forfeit for non-compliance with their promises. The ordinance was progressed.

COLUMBUS (O.) had a gas explosion the other day, the scene of the affair being at the corner of Main and Fourth streets. The smell of gas had been noticed at the point in question for some days, until finally an employe of the Street Department determined to discover its source. He did so—with his nose, first, and with a combination of lighted lucifer and brown paper. The usual result.

THE Flatbush (L. I.) Gas Company *might* build a new holder this summer; they certainly *ought* to.

THE Thomson-Houston parent company is getting ready for a big increase to its capital stock. They propose to give some of the new parchment away—to holders of record.

PIEDMONT (Va.) folks have organized an electric light company, capitalized in $20,000.

THE Consolidated Company, of this city, is to build a new holder at one of its west side stations.

THE following bids for the public lighting of Memphis, Tenn., were opened, read and referred: Brush Electric Light Company, 2,000-candle power arcs, $16 each per month. Memphis Gas Light Company, burners rated to 5 cubic feet, 20-candle power gas, moonlight table, supply to be maintained at the rate of $1.25 per 1,000 cubic feet. Equitable Gas Company, similar conditions, but rate to be $1.67 per 1,000 cubic feet.

THE Meriden (Conn.) street lamps (arc system) are now extinguished at 1 A. M., instead of 3 A. M. as before.

THE Treacy Carbon Lamp Company (organized May, 1887, in Chicago) is to be wound up, if the Circuit Court listens favorably to the petition of 22 shareholders, who aver that there is no possible reason for the existence of the Company, as Treacy's inventions are in the nature of a fraud on the petitioners.

WE understand that Galena, Ills., is to partly illuminate, for a year, her streets by means of 100 incandescent lamps of 24-candle power each. While we are not cognizant of the rate to be paid, we are quite certain that the contract will not have a long life. Incandescent electric lighting for streets is an utter failure.

THE Twenty-first Ward Gas Works (Phila.) will be shut down on the 15th inst.

Gas-propelled Carriage.

Kuhlow's Review says that Messrs. Benz & Company, of Mannheim, have lately exhibited in Munich their motor in which gas is the propelling agency. The gas is generated by the contrivance from benzine or analagous material. The motor, which is not visible from without, is placed in the rear of the carriage, which has three wheels, over the main axle, and the benzine used in its propulsion is carried in a closed copper receptacle secured under the seat, from which it passes drop by drop to the generator, and which holds enough benzine for a journey of about 75 miles. The gas mixture is ignited in a closed cylinder by means of an electric spark—a very safe and reliable arrangement. After regulating the admission of the gas the motor can be started by simply turning a hand lever. The operator mounts upon the seat, and by pressing the lever at his left sets the motor in motion, which then starts, the carriage being connected with the back wheels. The speed can be regulated at will by turning the lever backward or forward, and by pulling on the lever the motion can be completely stopped. The vehicle is steered like a tricycle by a small front wheel. Its greatest speed is about 10 miles an hour. A quart of benzine is sufficient for a one-hour's trip, the cost of the motor power being thus about 3½d. per hour. The carriage is intended to seat four persons, and in appearance somewhat resembles an ordinary phaeton set on three wheels. We should, however, be very much surprised if these gas-propelled carriages ever obtain general use, as the electrical carriage will doubtless prove too formidable a rival for it.

Tensile Strength of Ropes.

M. A. Duboul, in a series of tests for determining the above, used a horizontal hydraulic press and a weighing apparatus consisting of a steelyard and sliding weight, by which tension up to 130,000 pounds could be recorded. For higher pressures a gauge on the body of the press was used. Specimens were fastened by winding each end on a grooved pulley of special construction. The usual length of specimens for testing was 13 feet.

The results of all the tests gave for the average tensile strengths of ropes the following:

	Pounds per Sq. Inch.
White hemp	10,500 to 11,200
Tarred hemp	7,700 to 8,400
White manila	9,800 to 10,600
White aloes	5,600 to 7,000
Flat, tarred hemp or manila	7,800 to 8,400

A factor of safety of four, or even three in some cases, is considered safe ropes.

A rope of unannealed wire has an ultimate tensile strength of about 52,000 pounds per square inch of section of metal; when annealed the ultimate strength is reduced to about 45,000 pounds, but the elongation is nearly doubled, being 12 to 15 per cent. in annealed wire. The best wire ropes for mining purposes have a much higher tensile strength. Another authority on this subject says that the tensile strength of a wet rope is only one-third that of the same rope when dry, and that a rope saturated with soap or grease is still weaker.

THE AMERICAN
GAS LIGHT JOURNAL

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PROPRIETORS.

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ASST. EDITOR—T. J. Cunningham.
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LIGHT, HEAT, STEAM, WATER SUPPLY,
VENTILATION, SANITARY IMPROVEMENT,
AND GENERAL SCIENCE

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PHILADELPHIA.—PRATT & CO., Corner Ninth and Arch Streets.
Germany.—B. WESTERMANN &CO., of New York.

MONDAY, MARCH 11, 1889.

The Market for Gas Securities.

Consolidated has been steady to strong during the week, the range in values not having exceeded over 1½ points, quite a large number of transactions being recorded. Investors are quietly picking up the floating stock.

The one million of Equitable new stock is now on the regular call of the Exchange, but the added movement in these shares was not noticeable in the transactions. The capital stock of the Company is thus bought up to four millions. In the listing application the main particulars given seem to be that the total assets of the Company are put at (January 1, 1889) something in excess of 6.1 millions dollars; a main mileage of 114; meters, 23,574; and maximum producing capacity of works, 7½ millions cubic feet per diem. In the assets tables the works are inventoried at $2,501,952.

Brooklyn shares are unsettled as to values, old Brooklyn being off a trifle, whereas Citizens has almost recovered the depression caused by the January disaster. Nassau and Metropolitan are stronger, while Fulton-Municipal is about as before. The contest for control in the Citizens Company is not so warm as it was, one broker putting it that the March winds seem to have dried out the ardor of certain of its would-be purchasers.

The Boston deal is soon to come to a head, for at the annual meeting of the Company the election for directors was postponed to a late date in March. The St. Louis situation seems to be all in favor of the Laclede Company. The capital stock of the newly-organized Company to supply Cicero (Ills.) with gas, water and electricity, has been reduced to $100,000.

The property of the Duluth (Minn.) Gas and Water Company has been bonded in the sum of $500,000 to the Central Trust Company, of this city. A corporation to be known as the Pacific Loomis Gas Association has been organized in San Francisco, by Messrs. D. H. Ward, James G. and A. T. Eastland, H. Havens and W. B. Kollmyer. It is capitalized in $500,000. The Messrs. Eastland are known to us as men of wealth, Mr. J. G. Eastland being well known to the fraternity of the Pacific coast. Baltimore shares show no change of moment, and the canvass for proxies in the next annual meeting of the Consolidated Company is not so fierce just now. Chicago gas bonds are in good demand.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks,

16 WALL ST., NEW YORK CITY.

MARCH 11.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	83	83¼
Central	466,000	50	—	—
" Scrip	220,000	—	47	57
Equitable	4,000,000	100	112	117
" Bonds	1,000,000	—	113	115
Harlem, Bonds	170,000	—	—	—
Metropolitan, Bonds	658,000	—	115	118
Mutual	3,500,000	100	98	100
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern	125,000	50	30	—
" Scrip	108,000			
Yonkers		50	90	100
Richmond Co., S. I.	300,000	50	55	60
" Bonds	12,000	—	—	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	100	102
Citizens	1,200,000	20	55	—
" S. F. Bonds	320,000	1000	—	103
Fulton Municipal	3,000,000	100	125	127
" Bonds	300,000		—	106
Peoples	1,000,000	10	72	74
" Bonds (5's)	368,000	—	97	—
" " (6's)	94,000	—	100	—
Metropolitan	1,000,000	100	89	90
Nassau	1,000,000	25	111	—
" Ctfs	700,000	1000	100	103
Williamsburgh	1,000,000	50	120	122
" Bonds	1,000,000	—	111	112
Out of Town Gas Companies.				
Boston (Mass.) Gas Co	2,500,000	500	240	—
Buffalo Mutual, N. Y.	750,000	100	90	95
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	—	—
" " Bonds.	45,000	—	—	—
Chicago Gas Trust	25,000,000	100	43¾	—
Cincinnati G. & C. Co.	6,000,000	100	202	203
Consumers Toronto	1,000,000	50	192	—
Central, S. F., Cal.			—	90
Capital, Sacramento, Cal.			58	—
Consolidated, Balt.	11,000,000	100	44½	44¾
" Bonds	6,400,000		107	107½
Hartford, Conn	750,000	25	120	130
Jersey City	750,000	20	165	170
Laclede, St. Louis, Mo.	2,000,000	100	—	115
Louisville, Ky	2,570,000	50	125	130
Little Falls, N. Y.	50,000	100	—	100
" Bonds	25,000	—	100	103
Montreal, Canada	2,000,000	100	204	210
Memphis (Tenn.) Gas	750,000	100	48	51
" Bonds.	240,000	100	103	—
New Haven, Conn		25	193	197
Oakland, Cal.			34¾	35
Peoples, Jersey City		—	60	61
" " Bonds.			—	—
Paterson, N. J.		25	90	—
Rochester, N. Y.		50	75	80
Syracuse, N. Y.	500,000	25	—	—
St. Louis, Missouri	600,000	50	—	—
San Francisco Gas Co.				
San Francisco, Cal.	10,000,000	100	62½	62¾
Washington, D. C.	2,000,000	20	190	194
Wilmington, Del.		50	200	208

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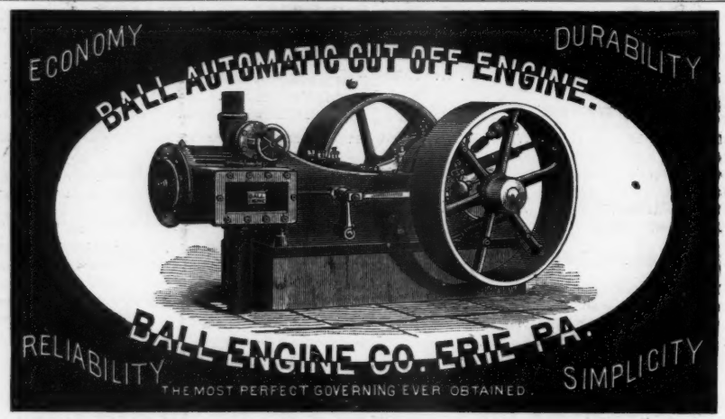

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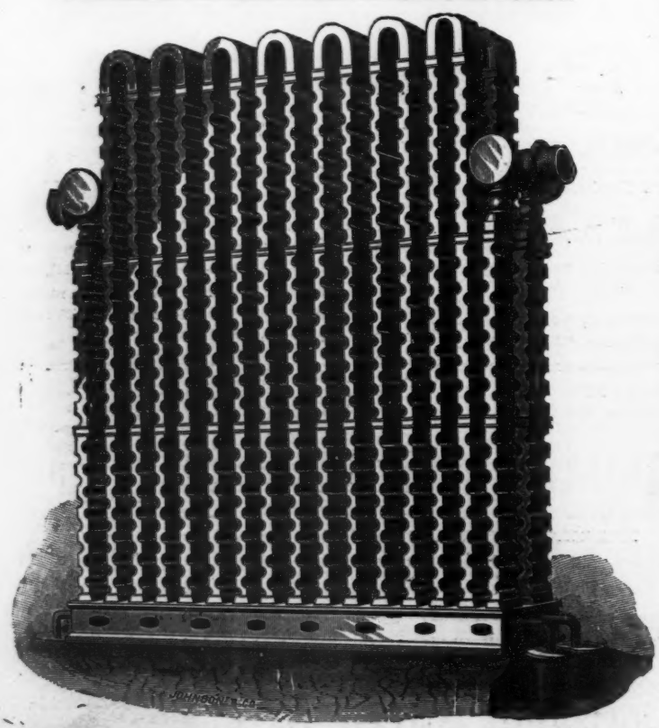

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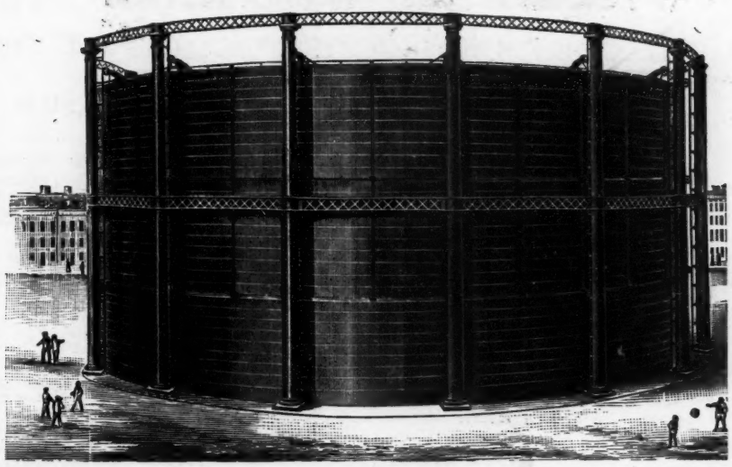

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Aldershot	200,000
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Amsterdam	1,500,000
"	1,500,000
Annaberg	200,000
Arcachon	100,000
Animal Charcoal Co	200,000
Altoona, U.S.A.	350,000
Buxton	250,000
Bradford	1,000,000
"	1,250,000
"	1,250,000
"	1,250,000
"	1,000,000
"	1,000,000
"	3,000,000
Bremen	150,000
Baltimore, U.S.A.	1,000,000
"	1,000,000
"	1,000,000
Balmain, N.S.W	125,000
Bishops Stortford	150,000
Blackpool	400,000
Brussels	1,250,000
"	1,250,000
"	750,000
"	1,250,000
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"	20,000
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Bexhill	125,000
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"	1,000,000
" **Nassau**	1,000,000
Brunner, Mond & Co.	400,000
Cheltenham	2,000,000
Cannes	200,000
Croydon	1,500,000
Copenhagen	200,000
Clevedon	200,000
Columbus, U.S.A.	500,000
Cincinnati, "	1,500,000
" "	1,500,000
Chicago "	3,000,000
" "	1,000,000
" "	1,000,000
Chemnitz	1,000,000
Crewe	1,250,000
Colonial Gas Works Co	100,000
Cadiz	300,000
Charlottenburg	600,000
Dudley	750,000
Driffield	100,000
Dukenfield	500,000
Dover	750,000
"	1,000,000
Deal	200,000
Derby	1,500,000

	Capacity. Cubic feet per day.
Dublin	3,000,000
Dowlais	100,000
Douai	500,000
Denton	500,000
Derby, U.S.A.	350,000
Denver, "	500,000
" "	1,000,000
Dusseldorf	750,000
"	500,000
Dumfries	250,000
Dunedin, N.Z	400,000
Darlington	1,250,000
Detroit, U.S.A	750,000
Edinburgh	1,500,000
"	2,000,000
Enfield	300,000
Essen	300,000
Elbing	150,000
Falmouth	150,000
Frankfort	300,000
Farnworth	400,000
Fenton	400,000
Friedenshutte	500,000
Furth	400,000
Freiburg	200,000
Goole	250,000
Glossop	300,000
Guildford	300,000
Gloucester	1,250,000
Gera	300,000
Grafton, N.S.W	100,000
Grieg	300,000
Georgetown, U.S.A	250,000
Gluckauf	200,000
Heywood	600,000
Holywood	125,000
Huy	70,000
Harrow	250,000
Harrogate	250,000
Halstead	150,000
Heilbronn	200,000
Havana, Cuba	750,000
Hastings	1,500,000
Huddersfield	300,000
"	750,000
"	1,500,000
Hof	200,000
Hampton Wick	500,000
Heckmondwicke	500,000
Haverfordwest	100,000
Halifax, N.S.	350,000
Hamm	200,000
Halle	400,000
Heidelberg	300,000
Hartford, U.S.A	1,000,000
Ilkeston	300,000
Inverness	250,000
Ilkley	200,000
Ilford	100,000
Kingston-on-Hull	400,000
Kidderminster	750,000
Kidsgrove	100,000
Konigberg	1,000,000
King's Lynn	300,000

LONDON:—

The Gaslight and Coke Co.:	
Beckton	1,250,000
"	1,250,000
"	1,250,000
"	1,250,000
"	1,250,000
"	1,250,000
"	2,500,000
"	2,500,000
Silvertown	1,000,000
Bromley	2,000,000
"	1,500,000
"	1,500,000
"	1,500,000
"	2,000,000
"	1,500,000

LONDON—*Continued.*	Capacity. Cubic feet per day.
Shoreditch	2,500,000
Pancras	1,500,000
"	1,500,000
Pimlico	2,000,000
Nine Elms	3,000,000
"	3,000,000
South Metropolitan Co:—	
Greenwich	3,000,000
Woolwich	400,000
Vauxhall	3,000,000
"	3,000,000
Lea Bridge	300,000
West Ham	1,500,000
Leeds	2,000,000
"	3,000,000
"	3,000,000
"	3,000,000
"	3,000,000
"	2,000,000
Leominster	150,000
Leiden	560,000
"	600,000
Liverpool	2,000,000
"	2,000,000
"	2,000,000
"	2,000,000
"	2,000,000
"	3,000,000
Lincoln	1,000,000
"	600,000
Lowell, U. S. A	1,000,000
Louisville "	1,500,000
Long Eaton	500,000
Lilie	900,000
"	450,000
"	750,000
"	250,000
"	250,000
Luckenwalde	330,000
Liegwitz	300,000
Lincoln, U. S. A	250,000
Lawrence "	500,000
Lynn "	300,000
Lyons	1,500,000
Maidstone	1,000,000
Marseilles	1,500,000
"	1,500,000
Mons	500,000
Malines	250,000
Melbourne	1,500,000
"	1,500,000
"	1,500,000
"	1,500,000
"	1,500,000
Manchester	2,500,000
Middleton	400,000
Manley, N. S. W.	100,000
Minneapolis, U. S. A.	750,000
Magdeburg	300,000
Memphis, U. S. A	750,000
Nottingham	1,250,000
"	2,500,000
"	2,500,000
"	2,000,000
"	1,500,000
"	2,000,000
Newport, U.S.A	430,000
Newmarket	150,000
Newark, U.S.A	680,000
Northfleet	200,000
New York, U.S.A	2,000,000
Nice	600,000
Newcastle, N. S. W.	200,000
Numea, "	100,000
Namur	250,000
Newark	350,000
Oldbury	500,000
Otley	200,000
Oswestry	250,000

	Capacity. Cubic feet per day.
Ober Schlesian	1,500,000
Otto & Co.'s Coke Works	1,500,000
Plymouth	2,000,000
Parramatta, N. S. W	100,000
Prescott	150,000
Providence, U.S.A.	750,000
"	750,000
Plauen	300,000
"	300,000
Portsmouth	2,500,000
"	2,500,000
Pittsburgh, U.S.A.	1,500,000
Portland, "	560,000
Pawtucket, "	500,000
Quebec	250,000
Radcliffe	750,000
Rouen	250,000
Ramsgate	1,000,000
Reigate	200,000
Richmond, U.S.A	250,000
Roxbury, "	500,000
Runcorn Soap Co.	20,000
Rockhampton, N. S. W.	125,000
Richmond	1,500,000
Reading	2,000,000
Reichenbach	200,000
Salford	1,750,000
"	1,750,000
"	1,750,000
Smethwick	750,000
Sydney, N. S. W.	1,000,000
"	1,000,000
"	2,500,000
"	50,000
"	50,000
Sunderland	1,500,000
St. Josephs, U.S A	250,000
Spa	100,000
Sevenoaks	300,000
St. Petersburg	2,000,000
"	1,500,000
St. Louis, U.S.A	2,000,000
"	2,000,000
"	1,000,000
Laclede	1,000,000
Silesian Coal Co.	600,000
San Francisco, U.S.A	2,000,000
"	2,000,000
Sheepbridge Coal Co.	40,000
Stettin	200,000
Singapore	300,000
Sutton	500,000
Tonbridge	150,000
Tipton	400,000
Tottenham	1,000,000
Toledo, U.S.A	750,000
Toronto	1,000,000
Uxbridge	300,000
Valparaiso	500,000
West Bromwich	1,000,000
Willenhall	250,000
Weston-super-Mare	500,000
Waltham	150,000
Wormwood Scrubs	300,000
Williamsburg, U.S.A	600,000
"	600,000
Wellington	150,000
Warwick	300,000
Wheeling, U.S.A	500,000
Walker	300,000
Westgate	100,000
Wilmington, U.S.A	500,000
Windsor, N. S. W.	100,000
Wolverton	100,000
Wellington, N. Z.	250,000
Whitchurch	175,000
Washington, U.S.A	2,000,000
Wallasey	750,000
Weimar	150,000
Wurzen	200,000
Worcester, U.S.A	750,000
Yeadon	500,000
Yeovil	250,000

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San Diego Gas Fuel and Electric Lt. Co.	San Diego, Cal.
Jackson National Gas Co.	Jackson, Mich.
Sioux Falls Gas Co.	Sioux Falls, Dak.
Dakota Gas and Fuel Co.	Grand Forks, Dak.
St. Johns Mutual Gas Co.	St. Johns, Mich.
Stillwater Gas Light Co.	Stillwater, Minn.
St. Paul Gas Light Co.	St. Paul, Minn.
Emporia Electric and Gas Light Co.	Emporia, Kas.
Van Wert Gas Light Co.	Van Wert, Ohio.
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San Francisco Gas Light Co.	San Francisco, Cal.
Shelbyville Gas Light Co.	Shelbyville, Ind.
Great Falls Gas Light Co.	Great Falls, N. H.
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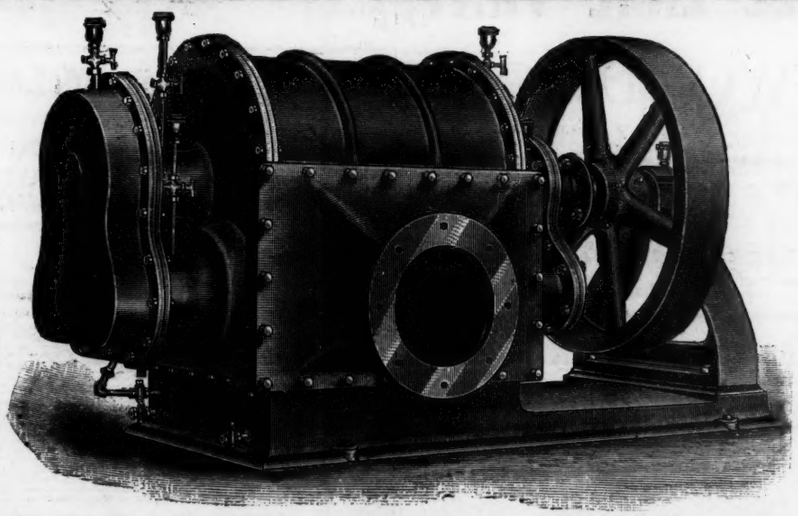

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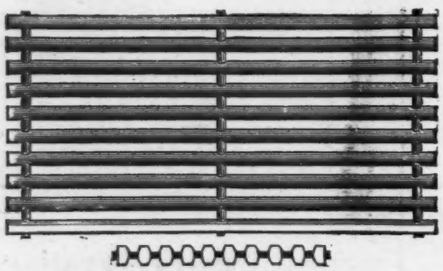

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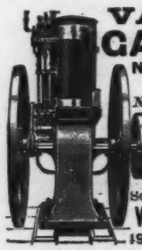

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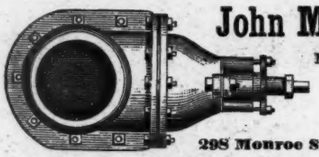

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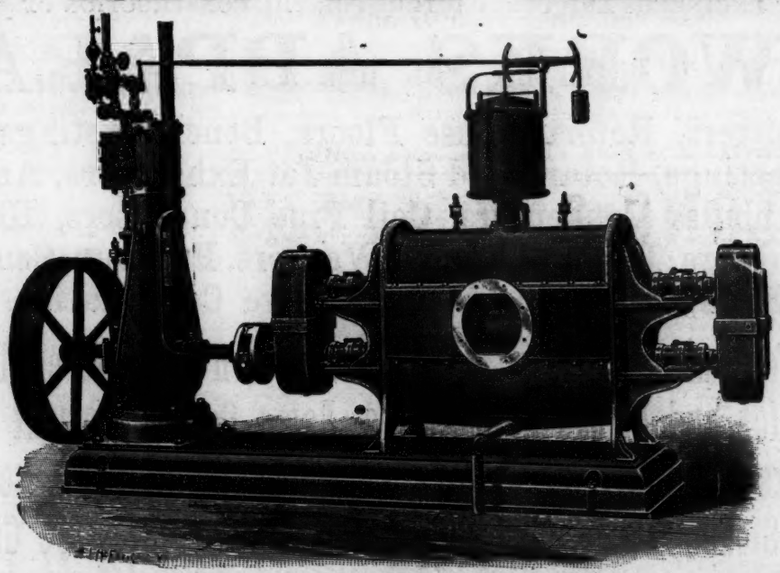

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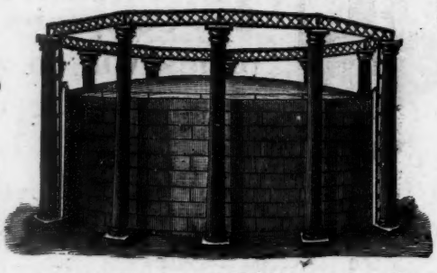

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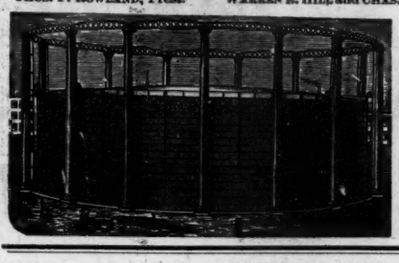

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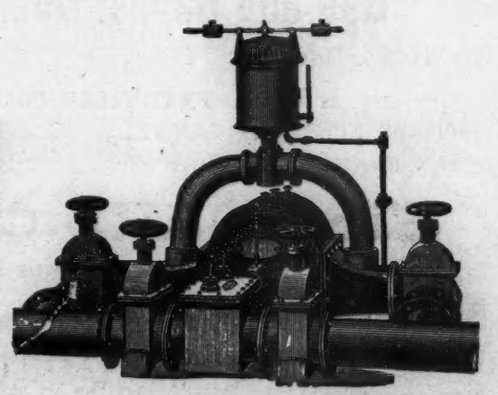

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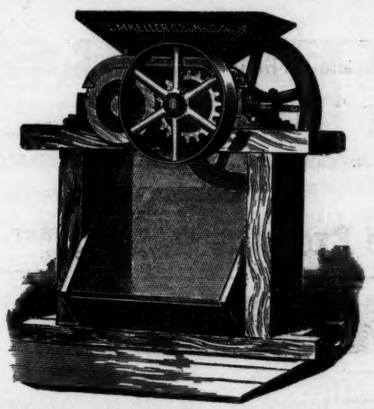

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50-H.P. STEAM ENGINE AND BOILER, Running a Plant of Fifty 2000-C.P. Arc Lamps 12 Hours.	
4,500 lbs. Indiana nut and slack, at $1.30 per ton	$2 93
Engineer, one night, at $50 per month	1 67
Trimmer, one day, at $40 per month	1 33
Superintendent or Electrician, one day, at $50 per month	1 66
Waste, etc., one day, at $20 per year	05
Water rent, one day, at $40 per year	11
Wheeling coal and removing ashes, at $4 per week	58
100 pairs carbons, at $18.50 per 1000	1 85
One pint cylinder oil, at 60 cents per gallon	07
One quart engine and dynamo oil, at 50 cents per gallon	13
Total	$10 38

50-H.P. OTTO GAS ENGINE, Running a Plant of Fifty 2000 C.P. Arc Lamps 12 Hours.	
9,200 cu. ft. gas, at 42 cts. per M. (for cost of gas see items below)	$3 86
Engineer not needed; engine is in care of Electrician or Supt.	....
Trimmer, one day, at $40 per month	1 33
Superintendent or electrician, one day, at $50 per month	1 66
Waste, etc., one day, at $20 per year	05
Water rent dispensed with (cooling water used over and over)	....
Handling of coal included in cost of gas	....
100 pairs carbons, at $18.50 per 1,000	1 85
One pint cylinder oil, at 60 cents per gallon	07
One quart engine and dynamo oil, at 50 cents per gallon	13
Total	$8 95

Expenses of depreciation, repairs, and interest omitted, being considered the same in both cases—though depreciation and repairs are much higher with steam on account of boiler and its appurtenances. Cost of gas in the holder we estimate for most of the Middle and Western States as follows: Coal, 30 cts.; labor, 20 cts.; purification, 2 cts.; total, 52 cts. Less coke, 7 cts., and tar, 3 cts.; leaving net cost of gas 42 cts. The items of Superintendence and repairs, being paid for by the gas sold to consumers, need not be charged on extra output for gas engine consumption. Where the cost of gas is higher than here figured, coal for steam use will be found proportionally higher, and final figures of comparison show same amount of saving.

Excess in Cost of Steam over Gas Power is thus $1.43, or nearly 16 per cent.

Coal for getting up steam and banking fires is not included in above figures, and should be added, thus increasing rate of economy of gas power beyond that shown by our figures.

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